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SELECTION OF LUMBER

FOR FARM AND HOME BUILDING

ADDITIONS AND REPAIRS to farm and home buildings, held in abeyance during a period of depression, must eventually be made. Wood is the proven and economical material to use for much of this work. The fullest efficiency to be derived from the use of wood in such construction, as with any other material, is in large part dependent upon how it is selected and how it is used. The selection of the wrong kind, the improper grade or size, or the following of faulty construction methods is uneconomical of the farm income as well as of the Nation's forest resources.

This publication is intended to aid all who want to acquire a basis for independent judgment as to the wood they are buying. To such prudent buyers a knowledge of the fact that they are using lumber and frame construction is insufficient. Accordingly this publication aims to assist in a careful estimation of the essential requirements for different building purposes, to show how the different kinds of woods meet these specific requirements, and to emphasize some of the principles frequently overlooked that should be followed in good construction.

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SELECTION OF LUMBER FOR FARM AND HOME BUILDING

By C. V. SWEET,[1] *principal engineer*, and R. P. A. JOHNSON, *engineer, Forest Products Laboratory,*[2] *Division of Research, Forest Service*

CONTENTS

THE LUMBER OF TODAY

LUMBER is now machined better, graded better, and seasoned better than formerly. In addition a wider selection of species and items is available. It is true that strong competition between dealers and between materials in some localities has resulted in bringing on the market lumber that is not what it should be with respect to size, grade, and seasoning. However, this does not mean that good lumber is not available at economical prices. It does mean that discrimination is necessary in buying lumber as well as in buying other materials—undoubtedly more necessary today than it was in the past.

CLASSIFICATION OF WOODS FOR PRINCIPAL FARM AND HOME USES

Wise selection of lumber involves first of all singling out the determining requirements of the job. Good judgment and keen insight applied in this connection yield high returns in ultimate satisfaction. After the requirements have been determined it is relatively easy to check the properties of the different woods to see whether these requirements would be met.

[1] Acknowledgment is made of the assistance received in the preparation of this bulletin from various members of the Forest Service.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

One readily jumps at the conclusion that he wants a wood of high strength for the siding of his house or barn when what he really needs is good painting qualities and good weather-resisting properties and ability to stay in place rather than strength. Or, more typically, he may think at first that he wants high bending strength for the joists for his house, whereas he really wants stiffness rather than strength and needs especially to be concerned with dryness, ability to stay in place, and minimum tendency toward shrinkage.

The number of uses and the variation in service requirements that a wood must meet are so numerous that it is practically impossible to classify woods in accordance with their suitability for the various uses on strictly factual data. There is, however, available the mature judgment of technical workers who have for years been impartially studying and testing the various woods and have observed the service rendered by many woods under varying conditions of service. The opinion of such workers has been used to supplement the factual data in the preparation of the following classification of woods for principal farm and home uses. To delay classifying woods for the various uses until complete factual data are available would result in an indefinite postponement.

The species have been classed conservatively. The classification, if followed literally, therefore, will not lead the user astray with respect to the results to be obtained in service. An occasional species may be underrated for a use or the range of suitability of a species may be underestimated. These imperfections resulting from limited data and the fallibility of human judgment may adversely affect the marketing of a species, but they are on the side of safety from the consumers' standpoint. In view of the need and demand for a simple, straightforward classification of wood, especially at this time of greatly increased building activity, minor imperfections do not warrant withholding from the public the best possible advice obtainable from technical workers in the public employ.

The classification is simple and applies to average typical conditions under which wood serves in a particular use. No attempt has been made to draw fine distinctions between woods. Neither is it to be inferred that all woods in the same class are equally suitable.

SUITABILITY OF WOODS FOR VARIOUS USES

[Based on a summation of technical opinions]

EXTERIOR TRIM (HOUSE)

Usual requirements:

Medium decay resistance, good painting and weathering characteristics, easy-working qualities, maximum freedom from warp.

Woods combining usual requirements in a high degree:

Cedars, cypress, redwood. (Heartwood only. Adapted to blinds, rails, and balcony and porch trim, where decay hazard is high.)

Northern white pine, sugar pine, western white pine, yellow poplar. (Heartwood only. Adapted to ordinary trim where decay hazard is moderate or low.)

Woods for special architectural treatments:

Chestnut, white oak. (Heartwood only. Used with natural finish.)

Woods combining usual requirements in a good degree:

Hemlocks, ponderosa pine, spruces, white fir. (When drainage is good.)

Douglas fir, western larch, southern yellow pine. (Special priming treatment advisable to improve paint-holding qualities.)

Grades used:

A, B, or B and Better finish is used in the best construction, C and D finish in more economical construction, and No. 1 or No. 2 boards where appearance is not important.

FLOORING (HOUSE)

Living Room and Bedroom Flooring

Usual requirements:

High resistance to wear, attractive figure or color, minimum warp and shrinkage.

Woods combining usual requirements in a high degree:

Hard maple, red and white oak. (Most commonly used hardwoods.)

Ash (white), beech, birch, walnut. (Not commonly used.)

Hickory, black locust, pecan. (Not commonly available. Hard to work and nail.)

Woods combining usual requirements in a good degree:

Cypress, Douglas fir, western hemlock, western larch, redwood, southern yellow pine. (Vertical grain.)

Cherry, red gum, sycamore (quartered). (Not commonly available. Highly decorative and suitable where wear is light and maintenance good.)

Grades used:

In beech, birch, and maple flooring the grade of Firsts is ordinarily used for the better class of homes and Seconds and sometimes Thirds in low-cost jobs. In oak the grade of Clear (either plain or quartered) is used in better class work and Selects and sometimes No. 1 Common in low-cost work. Other hardwoods are ordinarily used in the same grades as oak. When softwood flooring is used (without covering) in better class homes grade A or B and Better vertical grain is used. Grade D or C (vertical grain) is used in more economical and low-cost homes.

Kitchen Flooring (Uncovered)

Usual requirements:

Resistance to wear, fine texture, ability to withstand washing and wear without discoloring and slivering, minimum warp and shrinkage.

Woods combining usual requirements in a high degree:

Beech, birch, hard maple. (Fine textured.)

Woods combining usual requirements in a good degree:

Ash, red and white oak. (Open textured.)

Soft maple.

Woods combining usual requirements in a fair degree:

Cypress, Douglas fir, western hemlock, western larch, redwood, southern yellow pine. (Vertical grain preferred.)

Elm, hackberry, sycamore.

Grades used:

The flooring grades, Seconds in beech, birch, and hard maple, and Selects in the oaks are used in high-priced houses. In more economical construction Thirds in beech, birch, and hard maple, and No. 1 Common or No. 2 Common in the oaks are used. D (vertical grain) is the lowest grade of softwood that proves thoroughly satisfactory in high-class construction. A grade and B and Better grade (vertical grain) are used most extensively. No. 1 and No. 2 are serviceable in low-cost construction but wear unevenly around knots.

Porch Flooring

Usual requirements:

Medium to good decay resistance, medium wear resistance, nonsplintering, freedom from warping.

Woods combining usual requirements in a high degree:

Cypress, Douglas fir (vertical grain), western larch (vertical grain), southern yellow pine (vertical grain), redwood, white oak. (If full drainage is not obtainable only the heartwood of cypress, redwood, and white oak can be given a high rating.)

Black locust, walnut. (Usually impractical except when cut from home-grown timber.)

Grades used:

Grades C to A are used in the better types of homes. No. 1 and No. 2 are used in lower cost homes and are serviceable, but wear unevenly around knots, and the maintenance of paint on the knots is difficult. The superior paint-holding qualities and uniform wearing surface of vertical grain makes it preferred in all grades. Hardwoods, if used at all, should be of Select or No. 1 Common quality.

FRAMING (HOUSE)

Usual requirements:

High stiffness, good bending strength, good nail-holding power, hardness, freedom from pronounced warp. For this use dryness and size are more important factors than inherent properties of the different woods.

Woods combining usual requirements in a high degree:

Douglas fir, western larch, southern yellow pine. (Extensively used.)

Ash, beech, birch, maple, oak. (Sometimes used but more difficult to obtain in straight pieces and harder to nail and saw than preceding group.)

Cypress, redwood. (Seldom used.)

Woods combining usual requirements in a good degree:

Eastern hemlock, western hemlock, eastern spruce, Sitka spruce, white fir. (Extensively used.)

Northern white pine, ponderosa pine, sugar pine, western white pine. (Seldom used because of adaptability to more exacting uses. Low strength may be compensated for by the use of larger members.)

Chestnut, yellow poplar. (Seldom used.)

Woods combining usual requirements in a fair degree:

Elm, red gum, sycamore, tupelo. (Seldom used.)

Grades used:

No. 1 Dimension is the usual softwood grade for all framing items in both high- and medium-class construction. No. 2 Dimension renders satisfactory service once it is in place, but is not so straight or easily fabricated as No. 1. No. 3 Dimension is serviceable for studs and joists in the more economical and low-cost homes, especially when warped pieces and short lengths resulting from cutting out defects can be used to advantage. When hardwoods are used for framing, sound square edge is used in the better types of construction and for such items as joists, rafters, and sills. Hardwood Common Dimension is used in the more economical type of buildings and for studding in all types.

INTERIOR TRIM (HOUSE)

Interior Trim with Natural Finish

Usual requirements:

Pleasing figure, hardness, freedom from warp.

Woods combining usual requirements in a high degree:

Ash, birch, cherry, chestnut, oak, sycamore (quartered), walnut.

Woods adaptable to special selection and architectural treatment:

Pecky cypress; etched or special-grain cypress, Douglas fir, western larch, southern yellow pine; curly or bird's-eye maple.

Knotty cedars, ponderosa pine, spruces, sugar pine, white pine. (Lack hardness of the preceding group.)

Woods combining usual requirements in a good degree:

Cypress, Douglas fir, western hemlock, western larch, southern yellow pine, redwood, beech, maple, red gum. (With conventional treatment.)

Grades used:

High-class hardwood interior trim is usually of A grade. The softwood grade A or B and Better is commonly used in high-class construction. In the more economical types of construction C grade is serviceable. D grade requires special selection or some cutting to obtain clear material. Special grades of knotty pine, pecky cypress, and sound wormy oak and chestnut are available to meet special architectural requirements in some types of high-class construction.

Interior Trim with Paint Finish

Usual requirements:

Fine and uniform texture, hardness, absence of discoloring pitch, freedom from warp and shrinkage.

Woods combining usual requirements in a high degree:

Birch, cherry, walnut, yellow poplar.

Northern white pine, ponderosa pine, sugar pine, western white pine. (Where liability to marring is negligible and special priming is used.)

Woods combining usual requirement in a good degree:

Hemlocks, redwood, spruce, white fir.

Basswood, beech, red gum, maple, tupelo.

Cypress, Douglas fir, western larch, southern yellow pine, ash, chestnut, oak. (Used satisfactorily where requirements for smoothness of finish are not exacting.)

Grades used:

C is the lowest softwood grade commonly used for high-class paint and enamel finish. D can be used but requires some selection or cutting. No. 1 is used for ordinary or rough-paint finishes. In cheaper and more economical homes No. 2 may be used for ordinary or rough-paint finishes. Smooth-paint finishes are difficult to obtain and maintain over knots in No. 1, No. 2, and No. 3 grades. The A trim grade in the hardwoods is used for exacting requirements of high-class paint and enamel finish in high-cost homes. The standard grade of Firsts and Seconds is also used but requires some selection or cutting. No. 2 Common hardwoods are used for interior trim in the low-cost home, but in this class of home softwoods are generally used for the interior trim that is to be painted.

Lath (House)

Usual requirements:

Low shrinkage, easy nailing, nondiscoloration of plaster.

Woods combining usual requirements in a high degree:

Jack pine, lodgepole pine, northern white pine, sugar pine, ponderosa pine, western white pine, spruce, white fir, yellow poplar.

Woods combining usual requirements in a fair degree:

Cypress, Douglas fir, hemlocks, western larch, southern yellow pine, basswood.

Grades used:

Two grades of lath, No. 1 and No. 2, are available in practically all softwoods and in a number of hardwoods. In high-class and in the standard or medium types of construction No. 1 lath is usually used. No. 2 lath meets the less exacting requirements of cottages and lower-cost homes.

Roof Boards (House)

Usual requirements:

High stiffness, good nail holding, small tendency to warp, ease of working.

Woods combining usual requirements in a high degree:

Douglas fir, western larch, southern yellow pine. (Commonly used.)

Cypress. (Not commonly used because of adaptability to more exacting uses.)

Ash, beech, birch, chestnut, elm, hackberry, maple, oak, tupelo. (Seldom used because not readily available and hard to work.)

Woods combining usual requirements in a good degree:

Hemlocks, ponderosa pine, spruces, white fir. (Commonly used.)

Northern white pine, sugar pine, western white pine, redwood, yellow poplar. (Seldom used because of adaptability to more exacting uses.)

Grades used:

No. 2 boards are used extensively in higher type homes. In more economical construction both No. 2 and No. 3 are used. No. 3 is serviceable but not so tight as No. 2. No. 4 and No. 5 are available in some species but entail waste in cutting. When hardwoods are used No. 2 Common is adapted to the better class houses and No. 3 Common to the more economical.

SASH

Sash Used in a Dry Location (Low Decay Hazard)

Usual requirements:
Moderate shrinkage, good paint qualities, freedom from warping, ease of working, screw-holding power.
Woods combining usual requirements in a high degree:
Northern white pine, ponderosa pine, sugar pine, western white pine. (Principal woods used for sash.)
Cypress, redwood.
Woods combining usual requirements in a good degree:
Douglas fir, western larch, southern yellow pine. (Vertical grain. Use limited by milling and finishing characteristics.)

Sash Used in a Moist Location (High Decay Hazard)

Usual requirements:
High decay resistance. Moderate shrinkage, good paint qualities, freedom from warping, ease of working, screw-holding power.
Woods combining usual requirements in a high degree:
Northern white pine, ponderosa pine, sugar pine, western white pine. (Principal woods used for sash. Require good preservative treatment.)
Cypress, cedars, redwood, chestnut. (Heartwood only or sapwood when treated.)
Woods combining usual requirements in a good degree:
Douglas fir, western larch, southern yellow pine. (Heartwood only.)
White oak. (Harder to work and higher shrinkage than the softwoods.)
Grades used:
Grades of lumber used for sash are primarily of interest to manufacturers rather than users.

SHELVING (HOUSE)

Shelving with Natural or High-Class Paint Finish

Usual requirements:
Stiffness, good finishing qualities, freedom from pitch and warp.
Woods combining usual requirements in a high degree:
Ash, birch, maple, oak, walnut. (Suitable for natural finishes used principally to match interior trim.)
Cypress, redwood, yellow poplar. (Suitable for high-class paint finishes, but use limited.)
Northern white pine, ponderosa pine, sugar pine, western white pine. (Principal woods used for high-class paint finishes.)
Woods combining usual requirements in a good degree:
Douglas fir, hemlocks, western larch, southern yellow pine, spruces, white fir, basswood, chestnut. (May be used with either natural or paint finishes.)

Shelving with Unfinished or Plain Paint Coating

Usual requirements:
Stiffness, ease of working, freedom from pitch and warp.
Woods combining usual requirements in a good degree:
Northern white pine, ponderosa pine, sugar pine, western white pine. (Principal woods used.)
Cypress, hemlocks, redwood, spruces, white fir, basswood, chestnut, yellow poplar.
Douglas fir, western larch, southern yellow pine. (Softwoods with high stiffness.)
Birch, maple, oak. (Seldom used; difficult to work.)
Grades used:
The grade best adapted to use depends on the character of the shelving as well as on type of construction. C or a better grade is used for shelves that are to receive a high-class paint or enamel finish. D grade is service-

able but may entail some waste. No. 1 and No. 2 are used for shelving that is unpainted or receives only a rough-paint finish. No. 3 is serviceable, especially when cut into short lengths, but may entail some waste. When hardwoods are used for shelving in closets or storerooms No. 1 or No. 2 Common is used. These two grades are suitable for higher class shelving where short-length or narrow, clear cutting can be used to advantage.

SHINGLES (HOUSE)

Usual requirements:

High decay resistance, small tendency to curl or check, freedom from splitting in nailing.

Woods combining usual requirements in a high degree:

Cedars, cypress, redwood. (Principal shingle woods; heartwood only, edge grain.)

Northern white pine, ponderosa pine, sugar pine, western white pine. (Hand-made shingles or shakes from locally grown timber; require good preservative treatment.)

Chestnut, white oak. (Hand-made shingles or shakes from locally grown timber; require care in nailing.)

Grades used:

In western red cedar, cypress, and redwood No. 1 shingles (all heart, edge-grain clear stock) should be used for the longest life and greatest ultimate economy in dwelling roofs. Other all-heart but not edge-grain grades, such as No. 2 in redwood and western red cedar and Bests in cypress, are frequently used to reduce the first cost. Other grades permitting sapwood and flat grain are available and are used where low initial cost is the determining factor.

SIDING (HOUSE)

Usual requirements:

Good painting characteristics, easy working qualities, freedom from warp.

Woods combining usual requirements in a high degree:

Cedars, cypress, northern white pine, sugar pine, western white pine, redwood.

Woods combining usual requirements in a good degree:

Western hemlock, ponderosa pine, spruce, yellow poplar.

Woods combining usual requirements in a fair degree:

Douglas fir, western larch, southern yellow pine.

Grades used:

Redwood and cypress are available in special siding grades of Clear Heart, and western red and Port Orford cedar in a siding grade of Clear. In other softwoods the B and Better siding is used in the highest class of construction. Siding in more economical types of construction is usually of C or D grade, but No. 1 and No. 2 are available in a number of species.

STEPPING (OUTDOOR USE)

Usual requirements:

High decay resistance, nonsplintering, good bending strength and wear resistance, freedom from warping.

Woods combining usual requirements in a high degree:

Cypress, white oak (especially when quartersawn). (Heartwood only.)

Black locust, walnut. (Usually impractical except when cut from home-grown timber.)

Woods combining usual requirements in a good degree:

Douglas fir, western larch, redwood, southern yellow pine. (Vertical-grain heartwood only.)

Woods combining usual requirements in a fair degree:

Cedar, Douglas fir, western larch, southern yellow pine. (Flat grain.)

Grades used:

C or a higher grade of softwoods and Firsts and Seconds in hardwoods are used in high-class construction. In the less costly construction, No. 1 Common in hardwoods and as low as No. 2 grade in softwoods are used. No. 1 and No. 2 grades in softwoods are serviceable but wear unevenly around knots. Dense No. 1 southern pine is sometimes used in better type homes.

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SUBFLOORS (HOUSE)

Usual requirements:

Requirements are not exacting but high stiffness, medium shrinkage and warp, and ease of working are desired.

Woods combining usual requirements in a high degree:

Douglas fir, western larch, southern yellow pine. (Commonly used.)

Cypress, redwood, ash, yellow poplar. (Seldom used because of adaptability to more exacting uses.)

Woods combining usual requirements in a good degree:

Hemlocks, ponderosa pine, spruces, white fir. (Commonly used.)

Northern white pine, sugar pine, western white pine. (Seldom used because of adaptability to more exacting uses.)

Beech, birch, chestnut, elm, hackberry, maple, oak, tupelo. (Seldom used. Not readily available and hard to work.)

Grades used:

No. 2 boards are used extensively in higher type homes. In more economical construction both No. 2 and No. 3 are used. No. 3 is serviceable but not so tight as No. 2. No. 4 and No. 5 are available in some species but entail waste in cutting. When hardwoods are used, No. 2 Common is adapted to the better class houses and No. 3 Common to the more economical.

WALL SHEATHING (HOUSE)

Usual requirements:

Easy working, easy nailing, moderate shrinkage. All woods can be used for sheathing with satisfactory results although some woods are less time-consuming to work than are others.

Woods combining usual requirements in a high degree:

Cedar, cypress, hemlocks, northern white pine, ponderosa pine, sugar pine, western white pine, redwood, spruce, white fir, basswood, chestnut, yellow poplar.

Woods combining usual requirements in a good degree:

Douglas fir, western larch, southern yellow pine, cottonwood.

Grades used:

No. 3 grade of softwoods makes a serviceable sheathing when covered with good building paper. No. 1 and No. 2 make a tighter coverage but do not warrant omitting use of building paper. No. 4 and No. 5 are used in low-cost homes but are not generally available. They both entail some waste in cutting. When a hardwood is used for sheathing, No. 2 Common is adapted to the better type homes, and No. 3 Common to the more economical.

JOISTS, RAFTERS, PLATES (BARN)

Usual requirements:

High bending strength, good nail-holding power, moderate shrinkage, and medium ease of working. Woods of moderate bending strength can be used with fully satisfactory results if lower strength is compensated for by the use of larger members.

Woods combining usual requirements in a high degree:

Douglas fir, western larch, southern yellow pine.

Ash, beech, birch, maple, oak. (Hard to nail and work.)

Woods combining usual requirements in a good degree:

Cypress, eastern hemlock, western hemlock, redwood, eastern spruce, Sitka spruce, white fir, elm, red gum, hackberry, sycamore, tupelo, yellow poplar.

Woods combining usual requirements in a fair degree:

Cedar, northern white pine, ponderosa pine, sugar pine, western white pine, Engelmann spruce, basswood, chestnut, cottonwood. (Strength and stiffness equal to that of strongest species can be obtained by use of larger sizes.)

Grades used:

The No. 1 Timber or Dimension grade of most softwood species is used in large barns. Added strength and nail-holding power in large, high-class barns can be obtained by the use of the select merchantable grade of Douglas fir or the Dense No. 1 grade of southern pine. The No. 2 Timber or Dimension grade of all softwood species is used in small and low-cost barns. The hardwood grades used are sound square edge for large barns and common timber for small barns.

MANGERS (BARN)

Usual requirements:
Hardness, nonsplintering.
Woods combining usual requirements in a high degree:
Ash, beech, birch, black locust, Osage-orange, rock elm, hickory, maple, oak, soft elm, red gum, tupelo.
Woods combining usual requirements in a fair degree:
Cypress, Douglas fir, western larch, southern yellow pine, redwood.
Grades used:
The hardwoods are used in No. 1 Common and No. 2 Common grades, the softwoods in No. 1 or No. 2. In the more economical type of work softwood grades as low as No. 4 and hardwood grades as low as No. 3 Common are sometimes used.

ROOF BOARDS (BARN)

Usual requirements:
High stiffness, good nail-holding power, low shrinkage, medium decay resistance, freedom from splitting.
Woods combining usual requirements in a high degree:
Cypress, Douglas fir, western larch, southern yellow pine, redwood.
Woods combining usual requirements in a good degree:
Eastern hemlock, western hemlock, northern white pine, ponderosa pine, sugar pine, eastern spruce, Sitka spruce, white fir, beech, birch, maple, red oak. (Render good service in barns having low decay hazard.)
Chestnut, elm, red gun, white oak, yellow poplar. (Sometimes available from locally grown timber.)
Grades used:
No. 1 and No. 2 grades are used in large, high-class barns. No. 2 is serviceable. No. 2 or No. 3 is used in small and low-cost barns. No. 3 may entail some waste in cutting.

SIDING AND BARN BOARDS (BARN)

Usual requirements:
Good painting or weathering qualities, freedom from warping or splitting, medium decay resistance. Medium bending strength in walls without foundation or interior lining.
Woods combining usual requirements in a high degree:
Cypress, redwood. (Heartwood only. Adapted to barns without foundation walls or interior lining.)
Northern white cedar, western red cedar, chestnut. (Heartwood only. Require foundation wall or interior lining.)
Woods combining usual requirements in a good degree:
Northern white pine, ponderosa pine, sugar pine, western white pine, yellow poplar. (Heartwood only. Require foundation wall or interior lining.)
Douglas fir, western larch, southern yellow pine. (Heartwood only. When given special priming coats and protected against weathering by good paint maintenance. Adapted to barns without foundation walls or interior lining.)
Woods combining usual requirements in a fair degree:
Hemlocks, eastern spruce, Sitka spruce, white fir.
Grades used:
The grade of bevel siding used is generally higher than the grade used with drop siding or barn boards. When bevel siding is used it is usually in D to A grades. When drop siding is used it is usually in B and Better grade in the highest type barns, but No. 2 is serviceable and is used extensively in more economical types of barns. Barn boards are customarily used in lower grades than are either bevel or drop siding. No. 1 is used in the highest type barns and No. 2 in the more economical type. No. 3 and No. 4 barn boards are also used but entail some waste.

SILLS ON FOUNDATION WALLS (BARN)

Usual requirements:
Good nail-holding power, hardness, good decay resistance. High bending strength is important when piers or posts are used in lieu of walls.
Woods combining usual requirements in a high degree:
Cedars, cypress, chestnut, redwood, white oak. (Heartwood has high decay resistance.)

Woods combining usual requirements in a good degree:
Douglas fir, western larch, southern yellow pine, rock elm, yellow poplar. (High in strength and nail-holding. Heartwood has medium decay resistance.)
Woods combining usual requirements in a fair degree:
Eastern hemlock, western hemlock, northern white pine, ponderosa pine, sugar pine, western white pine, spruce, white fir, ash, beech, birch, soft elm, maple, red oak, sycamore. (Require good preservative treatment.)
Grades used:
Softwood sills in large barns are generally of the No. 1 Timber or No. 1 Dimension grade. No. 2 Dimension is used in small and low-cost barns. Both No. 1 and No. 2 Dimension grades have a high percentage of heartwood. All-heartwood pieces should be selected for sills, especially where foundation walls are low or where condensed moisture is liable to be absorbed by sills. Hardwood sills are usually of the sound square-edge grade in large barns and of the common-timber grade in small barns.

STALL FLOORING (BARN)

Usual requirements:
High decay resistance, uniform hardness (nonsplintering).
Woods combining usual requirements in a high degree:
White oak (heartwood only). (Principal wood used. Adapted to use where horses are sharp-shod.)
Black locust, Osage-orange. (Not usually available. Adapted to use where horses are sharp-shod.)
Ash, beech, birch, elms, black gum, hickory, maple, red oak, tupelo. (Require thorough preservative treatment. Adapted to use where horses are sharp-shod.
Woods combining usual requirements in a good degree:
Cypress, Douglas fir, western larch, southern yellow pine, redwood, red gum. (Heartwood only. Adapted to uses where the wear is light.)
Grades used:
The No. 2 Dimension softwood grade is used in all types of construction and is serviceable. No. 3 Dimension in softwoods is sometimes used and is serviceable when sound. The hardwood grades used for stall flooring are No. 1 and No. 2 Bridge Plank.

STANCHIONS AND STALLS (BARN)

Usual requirements:
High bending strength, medium decay resistance, hardness.
Woods combining usual requirements in a high degree:
Rock elm, black locust, white oak, Osage-orange.
Woods combining usual requirements in a good degree:
Ash, beech, birch, soft elm, red gum, hickory, maple, red oak. (Best adapted to use where mechanical wear is more important than decay hazard.)
Woods combining usual requirements in a fair degree:
Cypress, Douglas fir, western larch, southern yellow pine, redwood. (Best adapted to use where mechanical wear is less important than decay hazard.)
Grades used:
No. 1 or No. 2 Dimension is commonly used, although grades as low as No. 4 are used. Grades lower than No. 2 may contain some decay that will require culling or cutting of some pieces. The hardwood grade, sound square edge, is commonly used in the best construction and the common hardwood lumber in more economical construction. The common hardwood lumber may require some cutting.

STUDDING (BARN)

Usual requirements:
Good stiffness, good nail-holding power, medium freedom from warp, moderate ease of working. In some barns, especially dairy, preservative treated or good natural decay resistance is an added requirement.
Woods combining usual requirements in a high degree:
Douglas fir, western larch, southern yellow pine.
Cypress, redwood. (Heartwood decay resistance is high.)

Woods combining usual requirements in a good degree:

Hemlocks, northern white pine, ponderosa pine, sugar pine, western white pine, eastern spruce, Sitka spruce, white fir, chestnut, yellow poplar.

Ash, beech, birch, black locust, maple, oak. (Hard to nail and fabricate.)

Elms, red gum, hackberry, sycamore. (Difficult to fabricate because of warped pieces.)

Grades used:

No. 1 Dimension is the principal softwood grade used for studding in high-class construction. No. 2 Dimension is serviceable but is more difficult to fabricate because it contains more crooked pieces. No. 2 and No. 3 Dimensions are used in small, inexpensive barns. No. 3 entails some waste in cutting. Hardwoods in common dimension are used in all types of construction.

CONCRETE FORMS

Usual requirements:

Good stiffness, good bending strength, resistance to warping and splitting incident to installation and reuse, ease of nailing and cutting. With compensations in size of material or in frequency of bracing, almost all woods can be used in ordinary construction for concrete forms.

Woods combining usual requirements in a high degree:

Cypress, Douglas fir, western larch, southern yellow pine. (High strength and good reuse value.)

Western hemlock, eastern spruce, Sitka spruce. (Easy to cut and nail. Reuse high but lack strength of preceding group of woods.)

Woods combining usual requirements in a good degree:

Northern white pine, eastern hemlock, ponderosa pine, western white pine, redwood, white fir.

Woods combining usual requirements in a fair degree:

Basswood, beech, birch, cottonwood, gum, maple, oak. (Difficult to assemble or have low reuse value.)

Grades used:

No. 1 and No. 2 grades of softwoods and No. 2 Common hardwoods are used in forms with minimum of bracing. Forms in which the spacing is close or the loads are small use No. 2 or No. 3 softwood grades or No. 3 Common hardwoods. No. 4 in softwoods is sometimes used for simple rough forms. The percentage of No. 4 material that can be reused is smaller than with the better grades.

FENCE POSTS

Usual requirements:

High decay resistance, narrow sapwood ring, medium bending strength, high nail-holding power. Practically all species can be used if given a good preservative treatment.

Woods combining usual requirements in a high degree:

Black locust, Osage-orange. (Meet all requirements. Not readily available in all parts of the United States.)

Chestnut, white oak. (Sawed or split. Heartwood only. Generally available in the eastern States, but life shorter than preceding group.)

Cedars, cypress, juniper, redwood, catalpa. (Sawed or split. Heartwood only. Readily available but do not hold nails so well as preceding groups.)

Woods combining usual requirements in a good degree:

Douglas fir, western larch, southern yellow pine, tamarack. (Sawed or split. Heartwood only.)

Woods requiring thorough preservative treatment for long service:

Beech, birch, maple, red oak, elms. Equal the best woods when given a good preservative treatment.)

Hemlocks, spruces, white fir, basswood, cottonwood, red gum, tupelo, yellow poplar.

Grades used:

Fence posts are frequently round and have no standard grades. It is not practical to limit the amount of sapwood in round posts by rules or specifications.

GATES AND FENCES (EXCLUSIVE OF POSTS)

Usual requirements:

Moderate bending strength, medium decay and weather resistance, high nail-holding power, freedom from warp.

Woods combining usual requirements in a high degree:

Cypress, Douglas fir, western larch, southern yellow pine, redwood, white oak.

Woods combining usual requirements in a good degree:

Cedar, northern white pine, ponderosa pine, sugar pine, western white pine, chestnut, yellow poplar. (Small tendency to warp, weather well but low in strength and nail-holding power.)

Beech, birch, red gum, maple, red oak, tupelo. (Strong, hard, high in nail-holding power, but have greater tendency to warp and do not weather so well as preceding group.)

Eastern hemlock, western hemlock, white fir, spruce. (Intermediate between preceding groups.)

Grades used:

The No. 1 or No. 2 softwood and No. 2 Common hardwood grades are used in better and more substantial gates and fences. In lighter and more economical gates and fences No. 2 or No. 3 Common hardwood are used. A softwood grade as low as No. 4 may be used but entails some waste.

SCAFFOLDING

Usual requirements:

High bending strength, high stiffness, high nail-holding power, medium weight.

Woods combining usual requirements in a high degree:

Douglas fir, western larch, southern yellow pine, white ash.

Woods combining usual requirements in a good degree:

Cypress, redwood, spruces.

Birch, elm, maple, oak. (Hard to saw and nail.)

Woods combining usual requirements in a fair degree:

Sugar pine, ponderosa pine, western white pine.

Grades used:

Structural grades are usually required for scaffolding that must support loads under conditions which involve hazards to life or limb. Light scaffolding should be selected from softwood made of No. 1 Dimension or Better, and in hardwoods uprights can be selected from Common Dimension and planking from No. 1 Bridge Plank. Selection should eliminate all pieces with large or unsound knots and crossgrain. Some State building codes designate the grades to be used for scaffolding.

SILOS, TANKS, AND VATS

Usual requirements:

High decay resistance, low shrinkage.

Woods combining usual requirements in a high degree:

Cedar, cypress, redwood. (Heartwood only.)

Chestnut, white oak. (Quarter-sawn heartwood only.)

Woods combining usual requirements in a good degree:

Douglas fir, western larch, southern yellow pine. (Heartwood only, edge grain.)

Grades used:

The requirements for silos, tanks, and vats are best met by grades prepared especially for these uses. Such special grades are sold as tank, tank and boat, or silo stock and are available in most of the softwoods well adapted to these uses. The clear-heart grades available in cypress and redwood are also used extensively where requirements are high. There are no special grades in hardwoods for silos, tanks, or vats. Hardwoods, when used, should be bought on special order calling for all-heart, tight stock.

TROUGHS (FEED) AND SUPPORTS

Usual requirements:

Medium decay resistance, medium bending strength, nonsplintering, hardness.

Woods combining usual requirements in a high degree:
Cypress, redwood, chestnut, white oak. (Adaptable to use where decay hazard is high.)
Douglas fir, western larch, southern yellow pine. (Adaptable to uses that are subjected to rough treatment but only moderate decay hazards.)
Grades used:
No. 1 or No. 2 boards are used in the softwoods for large, long troughs. A softwood grade as low as No. 4 can sometimes be used to advantage in troughs in which the lumber is cut to short lengths. Of the hardwoods, the No. 2 Common grade is the most used. The No. 3 Common hardwood grade can sometimes be used if the material is cut to short lengths.

WINDMILL AND WELL PLATFORMS

Usual requirements:
High decay resistance, good bending strength.
Woods combining usual requirements in a high degree:
Cypress, redwood, chestnut, black locust, white oak. (Heartwood only.)
Woods combining usual requirements in a good degree:
Cedar, Douglas fir, western larch, southern yellow pine, rock elm. (Heartwood only.)
Grades used:
No. 1 or No. 2 Dimension in softwoods and sound square in hardwoods are the grades ordinarily used.

CLASSIFICATION OF WOODS ACCORDING TO IMPORTANT PROPERTIES

As may be observed from the usual requirements given in the preceding classification of woods for the principal farm and home uses, it is not often that one property alone controls the choice between woods. Usually it is the degree to which two or more properties are combined. Before the user can find the combination he needs for his specific purpose he must be prepared to think in terms of specific and individual properties.

Table 1, in which the various woods are classified according to several important properties, is of aid in the event a wood is required for a specific use and that use is not listed or departs markedly from the general classification given on pages 2 to 13. Class A in table 1 includes woods that are relatively high in the specific property or characteristic listed; class B, woods that are intermediate in the specific property or characteristic listed, and class C, woods that are relatively low in the specific property or characteristic listed.

TABLE 1.—*Broad classification of woods according to characteristics and properties*

[A, among the woods relatively high in the particular respect listed; B, among the woods intermediate in the particular respect listed; C, among the woods relatively low in the particular respect listed]

Kind of wood	Working and behavior characteristics											Strength properties				Surface characteristics of common grades						Distinctive uses	
	Hardness	Weight, dry	Freedom from shrinkage	Freedom from warping	Ease of working	Paint holding	Nail holding	Decay resistance of heartwood	Proportion[1] of heartwood	Amount of figure	Freedom from odor and taste (dry)	Bending strength	Stiffness	Strength as a post	Toughness	Number of knots	Size of knots	Number of pitch defects	Size of pitch defects	Number of other defects	Size of other defects	Farm	Commercial
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ash:																							
White	A	A	B	B	C	---	A	C	C	A	A	A	A	A	A	C	B	None	------	B	B	Handles, implements	Handles, vehicle parts.
Black	A	B	C	B	C	---	---	C	C	A	------	B	B	C	A	C	B	None	------	B	B	Implements	
Basswood	C	C	C	B	A	---	C	C	C	C	A	C	B	C	C	C	B	None	------	C	C	Woodenware	Fixtures, furniture parts.
Beech	A	A	C	C	C	---	A	C	B	B	A	A	A	B	A	B	B	None	------	A	A	Woodenware, containers, fuel.	Woodenware, flooring, furniture parts.
Birch, yellow	A	A	C	B	C	---	A	C	C	B	A	A	A	B	A	C	B	None	------	B	B	Millwork, furniture	Millwork, furniture.
Cedar:																							
Northern white	C	C	A	A	A	A	C	A	A	C	C	C	C	C	C	A	C	None	------	C	C	Posts, shingles	Posts, poles, boats, shingles.
Southern white	C	C	A	A	A	A	---	A	A	C	C	C	C	C	C	------	------	None	------	------	------	Posts, poles, shingles	Boat and tank stock, poles.
Western red	C	C	A	A	A	A	C	A	A	B	C	C	C	B	C	C	A	None	------	C	C	Shingles, siding, posts, and poles.	Poles, shingles, siding.
Eastern red	A	A	A	A	B	---	---	A	B	B	C	B	C	A	B	A	C	None	------	C	C	Posts	Chests, pencils.
Cherry	A	B	B	A	C	---	------	------	B	B	B	A	A	A	B	C	B	None	------	------	------	Furniture	Electrotype blocks.
Chestnut	B	B	B	A	B	---	B	A	A	A	B	C	C	C	B	C	A	None	------	A	B	Poles, posts, trim	Caskets, poles, core stock.
Cottonwood	C	B	C	C	B	---	C	C	C	C	B	C	B	C	B	C	C	None	------	C	C	Wagon boxes, containers	Boxes, cases, and furniture parts.
Cypress, southern	B	B	B	B	B	A	B	A	B	A	B	B	B	B	B	C	B	None	------	B	B	Silos, tanks, construction	Greenhouses, tanks, construction.
Douglas fir	B	B	B	B	C	C	B	B	A	A	C	A	A	A	B	B	B	B	B	B	B	Construction	Construction.
Elm:																							
Soft	A	A	C	C	C	---	A	B	B	A	A	B	B	B	A	B	B	None	------	A	A	Cheese boxes	Containers.
Rock	A	A	C	B	C	---	---	B	B	A	A	A	A	B	A	B	B	None	------	B	B	Implements	Cooperage.
Fir:																							
Balsam	C	C	B	B	B	B	---	C	B	B	A	C	C	C	C	A	C	None	------	B	B	Light construction	Pulpwood.
White	C	C	B	B	B	B	C	C	C	B	A	B	B	B	C	B	B	None	------	B	A	------do	Light construction, pulpwood.
Gum, red	B	B	C	C	B	---	B	B	B	B	B	B	B	B	B	C	B	None	------	C	C	Fruit and vegetable boxes	Furniture, millwork, containers.

Hackberry	A	A	C	B	C	---	---	------	C	A	A	B	C	C	A	C	A	None	------	B	B	Furniture	Automobile bodies.
Hemlock:																							
Eastern	B	B	B	B	B	B	B	C	B	B	A	B	B	B	B	B	B	None	------	A	A	Construction	Construction.
Western	B	B	B	B	B	B	B	C	B	B	A	B	A	B	B	B	B	None	------	B	B	-----do	Do.
Hickory:																							
True	A	A	C	B	C	---	A	C	B	B	------	A	A	A	A	B	A	None	------	B	B	Handles, implements	Implements, handles, sporting goods.
Pecan	A	A	C	B	C	---	---	C	B	B	------	A	A	A	A	C	A	None	------	A	A	Wagon and buggy parts	Furniture, automobile bodies.
Larch, western	A	A	B	B	C	C	A	B	A	A	C	A	A	A	B	A	C	C	C	A	C	Construction	Construction.
Locust:																							
Black	A	A	B	B	C	---	A	A	A	A	B	A	A	A	A	B	B	None	------	B	B	Fence posts	Insulator pins.
Honey	A	A	B	B	C	---	A	B	B	A	B	A	A	A	A	B	B	None	------	B	B	----------	
Maple:																							
Hard	A	A	C	B	C	---	A	C	C	B	A	A	A	A	A	B	B	None	------	B	B	Implements, flooring	Flooring, furniture, machine parts.
Soft	A	A	B	B	C	---	A	C	C	B	A	C	C	C	C	C	B	None	------	C	C	Fuel	Furniture.
Oak:																							
Red	A	A	C	B	C	---	A	C	B	A	------	A	A	B	A	C	A	None	------	B	B	Implement parts, construction.	Furniture, flooring.
White	A	A	C	B	C	---	A	A	B	A	------	A	A	B	A	C	A	None	------	B	B	Implement parts, posts, construction.	Cooperage, furniture, flooring.
Pine:																							
Ponderosa	C	B	B	A	A	B	B	(2)	C	C	C	C	C	C	C	B	B	B	B	B	B	Millwork, light construction.	Millwork, planing-mill products, construction, boxes.
Southern yellow	A	A	B	B	C	C	A	B	C	A	C	A	A	A	B	C	A	A	A	B	B	Construction	Construction.
White pine group:																							
Northern white	C	C	A	A	A	A	B	(2)	B	C	C	C	C	C	C	A	C	C	C	B	B	Millwork, siding	Millwork, planing-mill products, containers.
Western white	C	B	B	A	A	A	B	(2)	B	C	C	B	B	B	B	A	C	C	C	A	C	-----do	Do.
Sugar pine	C	C	A	A	A	A	---	(2)	B	C	C	C	C	B	C	A	B	C	C	B	C	Millwork	Patterns, millwork.
Poplar, yellow	C	B	B	A	A	---	B	C	B	B	A	B	B	C	A	C	B	None	------	C	C	-----do	Millwork, furniture.
Redwood	B	B	A	A	B	A	B	A	A	B	------	B	B	A	B	C	A	None	------	C	B	Silos, tanks, construction	Tanks, planing-mill products, construction.
Spruce:																							
Eastern	C	B	B	A	B	B	B	C	C	B	A	B	B	B	B	A	C	C	C	B	B	Construction	Pulpwood, musical instruments.
Sitka	C	B	B	A	B	B	---	C	C	B	A	B	A	B	B	B	B	C	B	B	B	Ladders, construction	Airplanes, construction.
Engelmann	C	C	B	A	B	B	C	C	C	B	A	C	C	B	C	A	C	C	C	B	B	Construction	Construction.
Sycamore	A	A	C	C	C	---	A	C	B	B	------	B	B	B	B	C	B	None	------	B	B	Baskets and boxes	Boxes and crates, millwork.
Tupelo	A	A	B	C	C	---	A	C	C	C	A	B	B	B	B	C	C	None	------	C	C	Fruit and vegetable boxes	Factory flooring, boxes and crates.
Walnut	A	A	B	A	B	---	---	A	B	B	------	A	A	A	A	C	B	None	------	C	C	Furniture	Furniture, millwork.

[1] Exclusive of the all-heartwood grades that are available on special order in birch, cedar, cypress, Douglas fir, red gum, southern yellow pine, redwood, and walnut.

[2] Conflicting opinion and absence of adequate test data preclude a definite rating; the authors recommend against relying on high decay resistance when this wood is used untreated.

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A general classification, such as is given in table 1, necessarily ignores small differences and sacrifices detail to some extent in favor of the simplicity desired by the ordinary user of lumber. All woods in the same class are by no means equal, and no attempt is made to draw fine distinctions between the species.

Table 1 assumes equal size, equal dryness, and for strength properties equal freedom from knots and the like, as between the different kinds of wood. So far as size is concerned, in actual practice all the different kinds of softwood lumber are governed by the same standards. However, some woods, mostly eastern hemlock, eastern spruce, and northern white pine, and some southern yellow pine, are commonly cut one thirty-second of an inch fuller than the general standard for 1-inch lumber. Where such oversized lumber is also dry at the time of dressing so that subsequent shrinkage does not reduce the thickness, there is, of course, an advantage in the strength due to oversize, and the classification as given in table 1 does not apply without modification. On the other hand, some boards of some woods are sold substandard, that is, three thirty-seconds of an inch under and some dimension material one-sixteenth of an inch under the standard thickness. Such differences must be taken into account in comparing the strength of species where strength is really important.

In actual practice different shipments of the same kind of lumber vary rather widely in dryness according to the source of the lumber. Some kinds of lumber run consistently drier than others because of the ease of seasoning the wood. A difference of one thirty-second of an inch in the thickness of boards and one-sixteenth of an inch in the thickness of dimension may exist due to difference in dryness at time of dressing. Regardless of the cause the fact stands out that a slight increase in size may easily compensate for inherently lower strength properties.

Hardwoods in some of their properties and uses differ substantially from softwoods. As a class they are heavier, harder, shrink more, and are tougher than the softwoods. Hardwoods and softwoods are very similar in stiffness, which means that reduced to a weight-for-weight basis the softwoods are much stiffer. In strength as a post, that is, the compressive strength endwise, and in bending strength the two groups are more directly comparable than they are in weight, toughness, and hardness, but there are more of the commercial hardwoods than of the commercial softwoods that can be rated high in bending strength. The softwoods are used principally in construction work, whereas hardwoods furnish most of the wood for implements, furniture, and other industrial uses.

HARDNESS

Hardness is the property that makes a surface difficult to dent, scratch, or cut. The harder the wood, other things being equal, the better it resists wear, the less it crushes or mashes under loads, and the better it can be polished; on the other hand, the more difficult it is to cut with tools, the harder it is to nail, and the more liable it is to split in nailing. Hardness is a property that one seeks in such uses as flooring, furniture, and tool handles.

There is a pronounced difference in hardness between the spring wood and the summer wood of some woods, such as southern yellow pine and Douglas fir. In these woods the summer wood is the denser, darker colored portion of the annual-growth ring. In such woods differences in surface hardness occur at close intervals on a piece, depending on whether spring wood or summer wood is encountered. In woods like maple, which do not have pronounced spring wood and summer wood, the hardness of the surface is quite uniform.

The classification of a species as a hardwood or softwood is not based on actual hardness of wood. Technically, softwoods are those cut from coniferous or evergreen trees, whereas hardwoods are those cut from broad-leaved and deciduous trees. Actually, some of the softwoods are harder than some of the hardwoods, and conversely.

The strong position that a number of woods hold among carpenters for building purposes is due in part to their softness and uniformity rather than to their hardness. Northern white pine, yellow poplar, and basswood are traditional examples. The ease with which these and other woods, such as ponderosa pine, sugar pine, and western white pine, can be cut, sawed, and nailed has put them in a high position for general use, and particularly for uses involving considerable working with machine and hand cutting tools. It is generally recognized that differences among woods in the matter of hardness are sufficiently great to have an important bearing on the choice of woods for such uses as flooring and furniture, on one hand, and for siding, millwork, and cabinets, on the other.

For classification of woods according to hardness, see column 2, table 1.

WEIGHT

Weight, in addition to being important in itself, is a reliable index of the strength properties of dry wood when the degree of dryness and actual sizes are the same. A heavy piece of dry wood is stronger, as a rule, than one lighter in weight whether of the same or of a different species.

Weights as commonly expressed are either the weight of the wood in the green condition or its weight in the air-dry condition. The former is its weight when cut from the living tree; the latter is the weight at which the lumber is best suited for use under the average outdoor conditions in the United States. The classification in table 1, column 3, is based on the air-dry condition.

FREEDOM FROM SHRINKAGE AND SWELLING

Most materials change in dimension with changes in temperature or moisture. Wood, like many other fibrous materials, shrinks as it dries and swells as it absorbs moisture. As a rule, however, much of the shrinking and swelling of wood in service is unnecessary and can be avoided by using wood that has been dried to the right moisture content.

In all kinds of wood the shrinkage or swelling in the width of a flat-grained board is nearly twice that of a quarter-sawn or edge-grained board of the same width. Edge-grained or quarter-sawn wood of a species having high shrinkage will therefore prove as sat-

isfactory as flat-grain stock of the kinds with inherently lower shrinkage. Wood has practically no shrinkage or swelling lengthwise of the grain. For shrinkage and swelling classification of woods see table 1, column 4.

The classification according to the amount of shrinkage as given in table 1 does not tell the user the whole story of the shrinking and swelling of different species in service. About half of the shrinkage is "taken out" of wood in thorough air-seasoning and about two-thirds in thorough kiln-drying. The taking out of the shrinkage in the foregoing amounts is sufficient for the ordinary uses to which wood is put. Of course, the shrinkage does not stay out when moisture is reabsorbed, but the important thing is to have it taken out at the time the wood is built into a structure. The rate at which drying and shrinkage occur in different kinds of wood is very important in practical usage. A wood that has a relatively low total shrinkage may dry so slowly that, in actual practice, it commonly gets into use before the proper amount of shrinkage has been taken out. Individual pieces of some woods, such as western larch, southern cypress, and redwood, frequently are slow to dry and therefore slow to shrink to their ultimate condition. Such pieces are liable to give a greater amount of trouble from shrinkage than the actual shrinkage values for the species indicate. This is a condition that can be controlled by making sure that such woods are thoroughly and uniformly dry prior to use. Ponderosa pine, sugar pine, northern white pine, western white pine, and the cedars give up their moisture quite readily and uniformly, and the chances of encountering shrinkage difficulties with such wood are correspondingly minimized.

The means of determining whether wood is dry enough for use is discussed on page 36.

FREEDOM FROM WARPING

The warping of wood is closely allied with shrinkage. Lumber that is cross-grained, or is from near the central core of the tree, tends to warp when it shrinks. Warping can be reduced to a minimum by the use of quarter-sawed dry material. The combined characteristics of warping and shrinkage determine the ability of wood to stay in place (columns 4 and 5 of table 1). Ability to stay in place, that is, remain flat, straight, and not change size, is desired in practically all uses. It is especially important in furniture, cabinetwork, window sash and frames, doors, and siding. All woods require proper seasoning in order to stay in place well.

The tendency of different woods to warp and twist during seasoning and incident to changes in atmospheric conditions once the wood is dry is shown in column 5 of table 1. The rules given on page 40 for preventing shrinkage are also effective for preventing warping.

EASE OF WORKING

Wood in general is easy to cut, shape, and fasten with ordinary tools directly on the building site. For some purposes the difference between woods in ease of working is negligible, but for others the smoothness and facility with which it can be worked have a decided

influence on the quality and cost of the finished job. In general, along with the tendency toward splitting in nailing, warping and twisting, and the weight in handling, ease of working is of first importance to the worker and indirectly to the one who pays the bill. The load-carrying capacity and wear resistance of the harder and denser woods should not be sacrificed unduly for the ease of working of the softer woods, but a reasonable balance must be drawn in selecting wood for a specific use. A skilled carpenter working with lumber that is well seasoned and manufactured can get good results from even the more refractory woods, whereas an unskilled worker stands the best chance of getting good results from the easier working woods. The condition of the cutting edges of tools is of first importance because unsuitable or dull tools may lose for any species of wood the advantage it may have because of its ease of working.

Classification of the more common woods according to their working qualities is shown in table 1, column 6. The classification is based on a combination of the hardness, texture, and character of the surfaces obtainable. Woods in the A class have soft, uniform texture and finish to smooth surface, woods in the C class are hard or nonuniform in texture or less easy than A or B woods to surface without chipping the grain, fuzzing, or grain raising. The B class is intermediate between the groups described.

PAINT HOLDING

The advantage that lies in being able to produce a change and variety of effects by the painting of wood can be realized with fullest economy by taking into account three factors, namely, (1) the kind of paint, (2) the circumstances of its application, and (3) the kind of wood. The first two factors are discussed on page 40; only the latter factor is dealt with at this point. The different kinds of wood vary considerably as to their painting characteristics, particularly for outdoor exposure. The principal softwoods are classed in table 1, column 7, according to their ability to hold paint under exposure to the weather.

Paint holds better on edge-grained or quarter-sawn pieces than it does on flat-sawn pieces. Knots in both the white and yellow pines do not retain paint so well as the sound knots of the cedars, hemlocks, white fir, or western larch. Among flat-grained boards, the bark side (the side nearest the bark of the log) is more satisfactory to paint than the pith side.

NAIL-HOLDING POWER

As a rule, fastenings are the weakest link in all forms of construction and in all materials; therefore the resistance which is offered by the wood itself to the withdrawal of nails is important. Usually, the denser and harder the wood the greater is the inherent nail-holding power. The grouping in table 1, column 8, of the commercial woods according to their inherent nail-holding power, is based on tests that measured the number of pounds required to pull nails from wood.

The size, type, and number of nails have a marked effect on the strength of the joint (fig. 1). The resistance to withdrawal of nails

increases almost directly with the diameter; that is, if the diameter of the nail is doubled the holding power is doubled, providing the nail does not split the wood when it is driven. The lateral resistance of nails increases as the 1½ power of the diameter. Of the three nails most commonly used, plain, cement-coated, and barbed, the cement-coated nail has, in well-seasoned wood, the highest holding power and the barbed nail the lowest. New or specialized types of nails are introduced on the market from time to time, some of them giving substantially improved results. One of these new nails is minutely pitted or etched in such a way as to increase the holding power even more than does the cement-coating just mentioned.

The moisture content of the wood at the time of nailing is extremely important for good nail holding. If nails are driven into wet wood they will lose about three-fourths of their full holding power when the wood becomes dry. So large is this loss that siding,

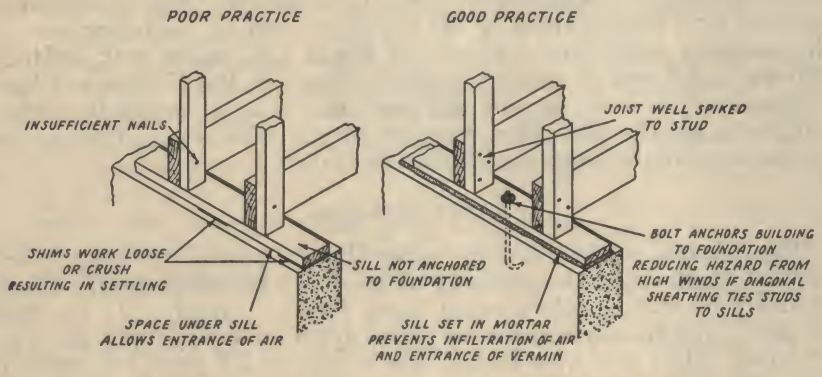

FIGURE 1.—Good and poor practice with foundation sills.

barn boards, or fence pickets are very likely to become loose when nails are driven into green wood even when the best of nails and nail-holding woods are used. Barbed nails are better adapted for use with wet or poorly dried wood than either plain or cement-coated nails when for some unavoidable reason wood in such a condition must be used. The first and most important rule in obtaining good joints and high nail-holding power is to use well-seasoned wood.

The splitting of wood by nails greatly reduces their holding power. Even if the wood is split only slightly around the nail there is considerable loss in holding power. Because of hardness and texture characteristics some woods split more in nailing than do others. The heavy, dense woods, such as maple, oak, and hickory, split more in nailing than do the lightweight woods, such as basswood, spruce, and true firs. The nonuniform-textured woods, like southern yellow pine and Douglas fir, split more than do the uniform-textured woods like northern white pine, sugar pine, or ponderosa pine. The most common means taken to reduce splitting is the use of smaller nails. The number of small nails must be increased, of course, to maintain the same gross holding power. Blunt-pointed nails are now available on the market, and sharp-

pointed nails can be blunted, a handful at a time, on a grindstone or emery wheel. Blunt-pointed nails have a smaller tendency to split wood than do sharp-pointed nails. Too much blunting, however, results in a loss of holding power.

The old-fashioned cut nail with its blunt point has less tendency to split than does the modern pointed nail. Cut nails, however, do not have the holding power of the modern pointed nail.

DECAY RESISTANCE

Every material has its characteristic way of deteriorating under adverse conditions. With wood it is decay. Wood, of course, will last indefinitely if kept continuously dry. Fortunately, most wood in ordinary buildings is in dry situations and therefore not in danger of decay. It is only in certain parts of the buildings that decay resistance is of importance, such as where wood is damp or in contact with the ground. Hence, in order to protect wood from decay, there are three things to do either singly or in combination: (1) Make sure that the wood is dry when put in place and kept dry in service; (2) where moisture is certain to get in, as from contact with the soil, or liable to get in because drainage or ventilation is poor, use the heartwood of a decay-resistant species; or (3) use wood that has been given a good preservative treatment. (Figs. 2, 3, 4, and 5.) Means of preventing the accumulation of moisture and securing properly treated wood are discussed on pages 39 to 41.

The different kinds of wood are classified in accordance with their natural decay resistance in table 1, column 9. This classification applies solely to the heartwood, because sapwood of all species in the untreated condition has low decay resistance. Furthermore, this classification deals only with averages, and exceptions frequently occur because of variations in conditions of exposure, because of variations in the wood itself, and because of differences in the kinds of fungi that cause the decay. The classification in table 1 has application only where the wood is used under conditions that favor decay. The wood of all classes will last indefinitely if kept continuously dry.

HEARTWOOD CONTENT

Selection of wood for use untreated where the decay hazard is high must take into consideration the heartwood content. The decay resistance of even the class A woods in table 1, column 9, is in the heartwood. When the sapwood of the tree is characteristically narrow, as it is in the woods rated as class A in column 10, table 1, the lumber runs high in heartwood content even without special selection. When, however, the sapwood is characteristically wide, as in woods rated as class C and even in class B in column 10, table 1, the commercial run of lumber contains considerable sapwood. To obtain decay-resistant lumber, even in the species classed as A in decay resistance in column 9, table 1, it is necessary to eliminate the sapwood by special selection. Specially selected building lumber, sold in what is commercially known as "all-heart" grades, is procurable in southern cypress, redwood, western red cedar, Douglas fir, and southern yellow pine.

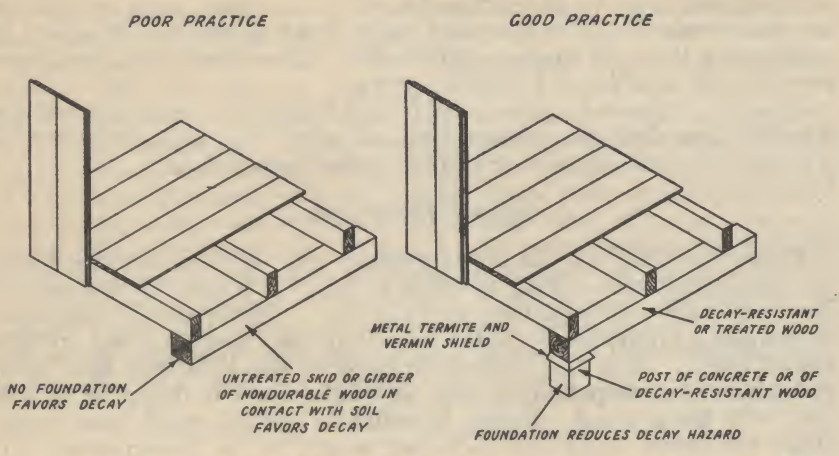

FIGURE 2.—Good and poor practice for foundations of temporary buildings.

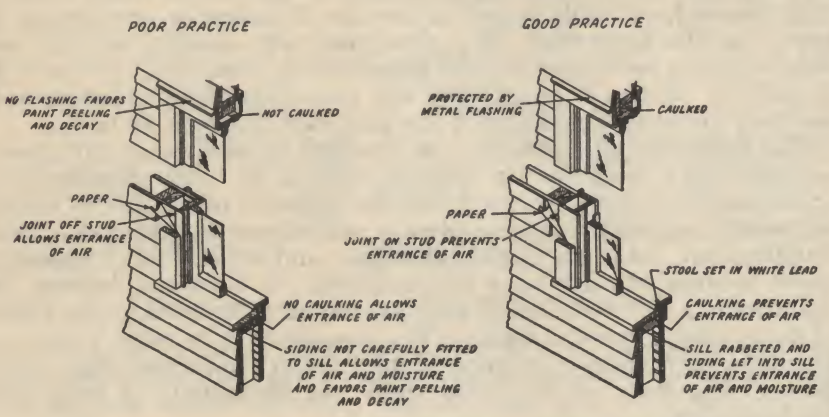

FIGURE 3.—Good and poor practice with window sash and frames.

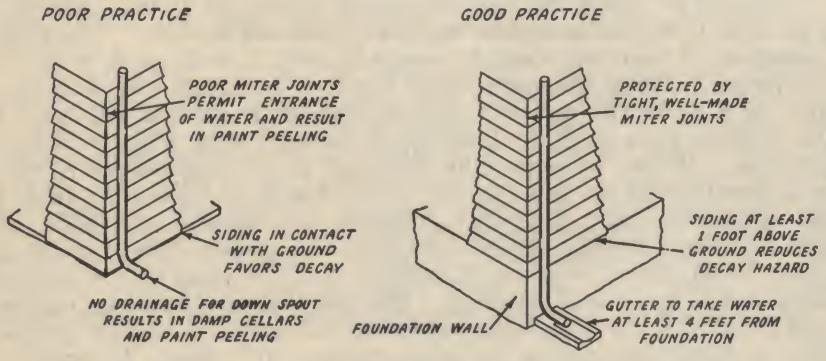

FIGURE 4.—Good and poor practice with siding and down spouts.

FIGURE

The choice of wood for woodwork that is to be varnished or waxed is usually based largely upon the character of the figure in the wood. Figure is due to different causes in different woods. In woods like southern yellow pine and Douglas fir it results from the contrast within the growth rings; in others, such as oak, beech, or sycamore, it results from the flakes or rays in addition to the growth rings; in maple, walnut, and birch it results from wavy or curly grain; and in red gum it results from infiltrated coloring matter. Except where the figure in wood results from flakes or rays, the figure is more pronounced in plain-sawn lumber than in quarter-sawn. Figure resulting from wavy or curly grain or from infiltrated color does not occur in all lumber of a given species but only in lumber from occasional logs. To be certain of getting figured lumber in maple, walnut, or red gum special selection is necessary.

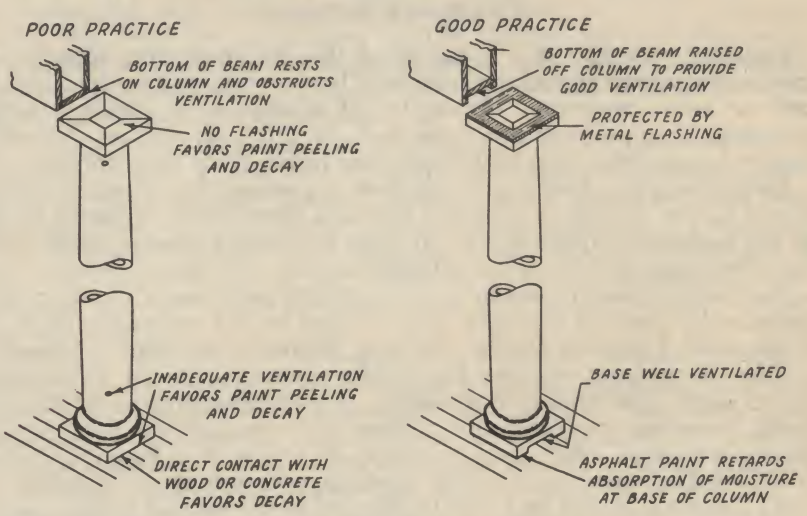

FIGURE 5.—Good and poor practice with porch columns.

The color of wood has a decided influence on the figure. Stains, however, are so commonly and easily applied to practically all woods that the natural color is usually not of the first consideration except where a very light color is desired.

A broad classification of the important kinds of lumber from the standpoint of the amount of figure they contain is shown in table 1, column 11. Woods classed as A are highly figured, and an ordinary commercial run will have a pronounced figure. Class B woods have more modulated figures and it sometimes requires special selection to obtain the desired figure. Class C woods are seldom satisfactory where figure is desired.

FREEDOM FROM ODOR AND TASTE WHEN DRY

None of the common woods has sufficient odor to prevent its entirely satisfactory use in building construction. It is only for food containers that odor and taste have to be taken into account. When

green, all woods have some odor and will impart a woody taste to very susceptible foods. Many woods, however, which have a disagreeable odor when green have practically no odor or taste after they are dried. The principal objection to odor and taste in wood is that they contaminate food, especially butter and cheese, in contact with the wood. The aromatic odor of the cedars is desirable in some uses, such as clothes closets and chests. The woods grouped in class A in table 1, column 12, have practically no odor or taste when dry and have been found by test or experience to be suitable for use in contact with foods that absorb odors. The woods in class C have strong resinous or aromatic odor and are unsuited for use where they come into direct contact with food that absorbs odors. Woods in class B, while they cannot be used in contact with very susceptible foods, like butter, do not have the strong odor and taste of the aromatic and resinous woods.

BENDING STRENGTH

Bending strength is a measure of the load-carrying capacity of members that are ordinarily used in a horizontal position and rest on two or more supports. Examples of members in which bending strength is important are barn rafters, girders, bridge stringers, wagon tongues, scaffold platforms, and heavy-duty floor joists.

Even though a species is low in bending strength it does not necessarily follow that it is unsuited for uses where this property is one of the essential requirements. It does indicate, however, that to obtain the same load-carrying capacity larger sizes are required.

A small increase in the height of a beam produces a much greater increase in bending strength than it does in the volume. Thus, an increase of 1 inch in the height of a 10-inch beam will increase its volume 10 percent, whereas the bending strength of the beam when set on edge is increased 21 percent. An increase in the width of a beam, however, increases the volume and bending strength by the same percentage, that is, an increase of 1 inch in a beam 10 inches wide will increase both bending strength and volume 10 percent.

No simple rule can be given to determine the size of girder, board, or plank required to carry a given load. In general, it may be said that for girders, the distance between the supporting posts in feet should not be greater than the height of the girder in inches. Lumber associations have prepared books that contain tables of safe loads for given spans, sizes, and qualities. Bulletin No. 145, Light Frame House Construction, issued by the United States Department of Commerce, contains tables showing allowable loads for given spans and sizes, together with detailed instructions for the use of the tables.

The softwoods in class A in table 1, column 13, dominate the structural field. They are used for both heavy construction, such as barns and bridges, and light construction, such as dwellings and small farm structures. In heavy construction, softwoods in class B are used only occasionally. In light construction, softwoods in class B are used extensively. Their light weight and ease of working enable them to compete with the stronger woods. Woods in class C are relatively unimportant in the structural field. They are seldom if ever used in heavy construction and only occasionally in

light construction. The hardwoods in class A and B have largely dropped out of the construction field not because they are unsuited to the use but because of their value for uses having more exacting requirements.

STIFFNESS

Stiffness is a measure of the resistance to bending or deflection under a load. In the floor joists of houses and in studding, stiffness is more important than actual breaking strength because it is deflection that must be reduced to the minimum in order to avoid plaster cracks in ceilings and vibration in floors. Stiffness is important also in shelving, ladder rails, beams, ax handles, and long, slender columns. Whereas stiffness is of great importance in floor joists the actual advantages of using a species of relatively high stiffness will be lost if the members are not fully dry at time of installation so that the fastenings, bracing, and bridging hold well. Well-seasoned, well-bridged, and straight joists of a kind of wood that is relatively low in stiffness may be counted upon to give better results than a simply inherently stiff wood. If the wood is properly dry and the installation is good, however, species differences with respect to stiffness are important.

Differences in stiffness between species may be compensated for by changing the size of members. Height and length of members have a greater effect on their stiffness than on other strength properties. A change of one thirty-second of an inch in the thickness of a standard 25/32-inch board produces a change of 12 percent in the stiffness of the board laid flat in a floor. A 10-inch joist has about one-fourth more wood in it than an 8-inch joist, but set on edge in a building it is more than twice as stiff.

The species are classified in accordance with their stiffness in table 1, column 14. Softwoods in class A and in class B dominate the uses where stiffness is the most important requirement. When woods in class C are used where stiffness is desired, it is because other properties are more important. The woods in class A have the highest stiffness, but they are heavier and harder than those in class B. Light weight is quite commonly desired in combination with stiffness. The softwoods meet this requirement much better than the hardwoods, and softwoods in class B are often chosen in preference to those in class A because the weight of the latter excludes them.

Stiffness is little affected by such defects as knots, checks, and shake. In light building construction, therefore, material of the sound, though knotty, grades may be used to good advantage for joists and studs because stiffness is more important than breaking strength in these items.

STRENGTH AS A POST

Compression members are generally square or circular in cross section, usually upright, supporting loads that act in the direction of the length. Strength as a post is an essential requirement of supports for root cellars, for storage bins, and for posts in similar heavy construction where the length is less than 11 times the smallest dimension. It is not important in fence posts which carry no loads. The size requirements of posts, with the smallest dimension less than one-eleventh of the length, is determined in small buildings by bear-

ing area, stiffness, and stability rather than by actual compressive strength. These requirements necessitate the use of posts large enough to carry much greater actual compressive loads than are ever placed upon them. No great consideration need therefore be given to compressive strength endwise in selecting a wood for small houses. Where exceptionally heavy loads are involved, as in supports for bins or root-cellars, consideration should be given to compressive strength shown in table 1, column 15. Even where compressive strength is an important requirement, the woods in any of the classes may be safely used, provided the lower strength of the woods in class B and class C is compensated for by the use of timber of larger cross-sectional area.

When the length is greater than 11 times the smallest dimension, the slenderness has increased to such an extent that stiffness has become an important factor in determining the load-carrying ability and the comparisons with respect to compression strength are of no special significance. Unbraced supports in machinery-storage sheds and barns with an attached lean-to are generally so slender that they should be judged by their stiffness rather than by their compressive strength.

TOUGHNESS

Toughness is a measure of the capacity to withstand suddenly applied loads. Hence, woods high in shock resistance are adapted to withstand repeated shocks, jars, jolts, and blows, such as are given ax handles, wheel spokes, and wagon tongues. The heavier hardwoods, like hickory, yellow birch, the oaks, maple, and ashes, are so much higher in shock resistance than the toughest of the softwoods that the hardwoods are used almost exclusively where an exceptionally tough wood is required.

None of the softwoods in table 1, column 16, is grouped in class A in toughness, and only two hardwoods, basswood, and yellow poplar, fall in class C. The woods in class A completely dominate the uses where toughness is the outstanding requirement, and hickory dominates class A.

Toughness is a desirable property in uses other than those in which it is an outstanding requirement. Tough woods give more warning of failure than do nontough woods. It is, therefore, a factor in beams and girders where heavy loads are applied and where failure will result in loss of life or heavy property damage. The warning given by tougher woods often make it possible to reinforce a member and thus prevent a complete failure. Softwoods in class B give warning of failure by detectable deflection and cracking noise, while softwoods in class C, in which the size of knots, pitch pockets, and the like are relatively large, break more suddenly at low deflections.

SURFACE CHARACTERISTICS OF COMMON GRADES OF LUMBER

Lumber is purchased by farm and home owners on account of its appearance as well as on account of its working characteristics and strength properties. The appearance is dependent largely on the grade, and there is some degree of uniformity in the appearance of

the same grade in different woods. Different woods are more uniform in appearance in the select grades than in common grades because most knots, pitch pockets, and the like are eliminated from the select grades. In the common grades, however, where knots and similar surface features are allowable, there are characteristic differences in the same grade of different woods. These differences affect the appearance of the wood and at times its suitability for a use. Table 1, therefore, includes in columns 17 to 22 a classification of various woods in accordance with the size and number of the more important surface features found in the common grades. The woods classed as C have the least number of these surface features; those classed as A have the most.

DISTINCTIVE USES

The distinctive uses to which a wood is put are indicative of its properties. A distinctive use is one to which a wood is especially fitted, not necesarily one for which the greatest quantity of the wood is used. The fact that a wood's distinctive use is for cheese boxes, or for pitchforks or ax handles, or for woodenware, or fence posts immediately tells one who is familiar with these uses much more about the wood than does a verbal description or a table of properties unless he has been trained in combining and evaluating the properties. A knowledge of the requirements for pitchfork handles obtained from actual experience gives a good idea of the combination of toughness, breaking strength, stiffness, and texture to be found in a wood used for that purpose.

The distinctive farm and commercial uses listed in table 1, columns 23 and 24, are therefore intended to supplement the data on properties and to aid in visualizing the general character of the wood produced by the combination of properties peculiar to the individual species and thus aid in judging the adaptability of the species to uses other than those for which service has proved them especially adaptable.

LUMBER GRADES AND SIZES

Lumber grades [3] that apply between the sawmill and retail yard are fairly well standardized in what are officially known as American lumber standards. So far as ordinary building lumber is concerned, the finish items consist of Selects (A, B, C, and D); the utility-board items of No. 1 Boards, No. 2 Boards, No. 3 Boards, No. 4 Boards, and No. 5 Boards; and the framing items of No. 1 Dimension, No. 2 Dimension, and No. 3 Dimension. As between the retail yard and the ultimate user, these standard grades have in the past applied less universaliy than between mill and yard. It has been the practice for the lumber retailer to quote prices and make deliveries on the basis of local grade classification or on his own judgment of what the user needs or will accept. In some cases this has been a very distinct service that the retailer has rendered. In other cases it has tended to confuse the user and make it difficult

[3] U. S. Department of Agriculture Department Circular No. 64, How Lumber is Graded, contains summarized description of the lumber grades used by the principal lumber-manufacturing associations. Out of print, but may be consulted in libraries.

for him to understand or evaluate different price quotations. There is now a growing practice to put indelible marks on all building lumber at the sawmill, stating the grade, species, size, and degree of seasoning, and the identity of the supplier. This grade- and trade-marking program is distinctly in the interest of the ultimate user.

The softwoods, which in the main are obtained from needle-leaved, evergreen, cone-bearing trees, are graded to meet fairly definite building requirements. The pines, firs, and hemlocks are familiar examples of softwood species. The select grades of softwoods are based on suitability for natural and paint finishes; A Select and B Select primarily on the basis of requirements for natural finishes, and C Select and D Select for paint finishes. The utility-board grades are based primarily on their suitability for general construction and general-utility purposes as influenced by the size, tightness, and soundness of knots.

The wood of the hardwood or broad-leaved trees, such as the oaks, maples, and birches, is graded on the basis of factory rather than of building requirements. Hardwood grades take into account the yield and size of cuttings with one clear face that can be sawed from the lumber, except in the case of hardwood flooring and trim, which are graded, like the softwoods, for building purposes. The two highest hardwood grades are known as Firsts and Seconds, and are usually sold combined. The other grade names for hardwoods are similar to those used for softwoods. Hardwood grades are omitted in the description of grades that follows because they pertain more to factory usage than to building.

STRENGTH FACTOR

The ordinary grades of building or so-called yard lumber are based on the size, number, and location of the knots, pitch pockets, and the like rather than on the strength of the clear wood. Knots, pitch pockets, and the like are so strictly limited in boards of A Select, B Select, and C Select softwood grades, both as to character and size, that they have practically no influence on the strength. These grades may therefore be considered as of maximum strength and adaptability. The D Select grade is primarily a cutting grade in that it permits boards with one fairly large knot or hole which would detract from the full strength if the board were to be used as a whole. There is little significant difference in strength between No. 1 Boards and No. 2 Boards. Both of these grades, while actually weaker than A Select, B Select, and C Select grades, provide material of about the highest strength properties demanded for construction purposes and are the recognized grades to use for permanent structures. As Nos. 3, 4, and 5 Boards permit large knots, holes, shake, and the like, the strength is substantially less than in the higher grades, where the pieces are for use as a whole.

In house floors and walls, where construction is designed to minimize vibration and deflection so far as possible, stiffness rather than breaking strength is the most important requirement. There is little difference in stiffness in the dimension grades above No. 3 because features other than decay, such as knots and knotholes, have little if any effect on stiffness.

FINISHING AND APPEARANCE FACTOR

With varnish and natural finishes, A and B Select (commonly sold as B and Better) assure the best appearance. Some pieces in the B and Better grade are practically clear, although the average board contains one or two small surface features which preclude calling it clear. Where the very smoothest appearance is not required, C Select gives good satisfaction. The number of knots, pitch pockets, and other nonclear features per board in C Select averages about twice that of B and Better and the proportion of these features that are small knots is greater than in B and Better. Because of its decorative effects knotty lumber selected from No. 1 Boards and No. 2 Boards is frequently in demand for paneling.

For painting where wood is not exposed to the weather, the surface features permitted in C Select are such that they can be well covered by paint if the priming is properly done. D Select, with some cutting, gives almost as good quality as C Select. Some of the natural features and manufacturing imperfections are not much more numerous in D Select than in C Select. The number and size of the knots in D Select are considerably greater than in C Select, and often the back of the pieces is of lower quality. Where smoothest appearance at close inspection is required under exposure to the weather, A Select or B Select gives the best results. C Select and D Select give good results.

For painted surfaces that do not receive close inspection, such as those on barns, summer cottages, and the like, and where protection against the weather is as important as appearance, No. 1 and No. 2 are satisfactory. The larger knots and pitch pockets in No. 2 do not give as smooth and lasting a painted surface as the smaller ones do in No. 1, but the general utility is good.

TIGHTNESS FACTOR

No. 1 Boards are suitable for protection against rain or other free water beating or seeping through walls or similar construction. No. 1 Boards and the select grades are usually kept drier at the lumber yards than are the lower grades and will therefore shrink and open less at the joints if used without further drying. Where tightness only against leakage of small grain is required, No. 2 Boards with a small amount of cutting to eliminate occasional knotholes may well be used. No. 2 Boards, when used as sheathing with good building paper, are satisfactory in permanent construction or for temporary protection against the weather even though knotholes and other similar openings do occur.

WEAR-RESISTANCE FACTOR

Edge grain wears better than flat grain, sap side better than heart side, narrow-ringed better than wide-ringed, and clear wood more evenly than that containing knots. A Select is the only grade entirely free of knots. B Select, which ordinarily contains only a few small knots, withstands wear excellently. C Select has sufficient limitations on knots and surface characteristics to assure good wearing qualities. D Select and No. 1 Boards limit the size and

character, although not the number of knots, and are satisfactory where maximum uniformity of wear is not required.

DECAY-RESISTANCE FACTOR

The natural decay resistance of all woods lies in the heartwood, which is the wood in the interior of the tree extending from the pith to the sapwood. The decay resistance of the species so far as affected by grade therefore depends upon the proportion of heartwood in the grade. While this is true of all species, it is of practical importance only in woods with medium or high decay-resistant heartwood.

The lower grades usually contain more heartwood than do the select grades. If decay resistance is really needed for the purpose at hand the higher board grades, No. 1 and No. 2, are more decay resistant than are the select grades, except in the case of the special select grades known as all heart. The full decay resistance of grades below No. 2 is to some extent adversely affected by the presence of decay that may have existed in the tree or log before it was sawn into lumber. Under conditions conducive to decay, such original decay may spread, although some types of decay, notably peck in cypress and red heart in pine, are definitely known to cease to function once the lumber is properly seasoned.

PRICE FACTOR

The spread in price between select-finish and utility-board grades varies considerably from time to time, depending upon supply and demand. The price range between the lower select grades and the upper board grades of softwoods is frequently as much as 30 to 60 percent. With such a difference in price it is obviously important not to buy a better grade than is needed. Any tendency to buy the best the market offers for all uses is wasteful of both lumber and money, for in many uses the lower and cheaper grades will render as long and satisfactory service as the upper and higher priced grades (fig. 6).

The price spread between the combined grade of Firsts and Seconds and the common grades of hardwoods is also large, although of minor importance to builders because most of the hardwood purchased by them has already been manufactured into some form of finished product, such as flooring or interior trim. Roughly the combined grade of Firsts and Seconds has a market value from 75 to 100 percent greater than that of the highest common grade and contains from 25 to 50 percent more clear-face material. If large clear-face pieces are required they can best and possibly only be obtained from the combined Firsts and Seconds grade. If, however, only medium-sized or small clear-face pieces are required they can be obtained from common grades.

DRESSED THICKNESSES AND WIDTHS

Lumber as ordinarily stocked in retail yards is surfaced on one or two sides and on one or two edges. This is to make the lumber ready to use and uniform in size without further reworking and also to

avoid paying transportation costs on material that would have to be cut off on the job. The amount that is reasonable and desirable to dress off has varied considerably in the past and has been the subject of some controversy and misunderstanding among producing and consuming groups. In recent years, however, American lumber standards have been set up by the lumber trade with the

FIGURE 6.—Whether in a high- or low-priced structure, wood fulfills the building needs of the modern farm: *A*, An economical homestead in the North Woods; *B*, high-quality farm buildings on the Midwest Prairies.

assistance of Government agencies in such a way as to largely take care of the situation.

American lumber standards and common trade practices now provide dressed sizes as summarized in table 2. The table shows in column 2 the nominal dimensions, that is, the dimensions according to which lumber is usually described; column 3 shows the actual

dimensions of lumber when it is sold surfaced; column 4 shows the actual dimensions of lumber when it is sold rough-dry, that is, seasoned but not dressed. When the dimensions of dressed lumber are less than those shown in the table for the actual sizes enumerated, the lumber is known as substandard. Items of some woods are commonly sold in substandard sizes. It is well to check the dimensions before selecting a wood so that allowance can be made in both price and utility for substandard sizes or proper credit given for oversizes.

TABLE 2.—*Standard widths and thicknesses of rough and surfaced yard lumber*

Lumber described as nominal—		Actual dimensions when surfaced shall not be less than—	Actual dimensions when rough dry[1] shall not be less than—
	Inches	*Inches*	*Inches*
Thickness	1	25/32	29/32
	1¼	1 1/16	1 5/32
	1½	1 5/16	1 13/32
	1¾	1 7/16	1 9/16
	2	1 5/8	1¾
	2½	2 1/8	2¼
	3	2 5/8	2¾
	4	3 5/8	3¾
Width of finish	3	2 5/8	2¾
	4	3½	3 5/8
	5	4½	4 5/8
	6	5½	5 5/8
	7	6½	6 5/8
	8	7¼	7 3/8
	9	8¼	8 3/8
	10	9¼	9 3/8
	11	10¾	10 3/8
	12	11¼	11 3/8
Width of boards and dimension	3	2 5/8	2¾
	4	3 5/8	3¾
	5	4 5/8	4¾
	6	5 5/8	5¾
	7	6 5/8	6¾
	8	7½	7 5/8
	9	8½	8 5/8
	10	9½	9 5/8
	11	10½	10 5/8
	12	11½	11 5/8

[1] In a shipment of rough dry lumber 20 percent may be not more than one-thirty-second of an inch under the thicknesses shown.

STANDARD LUMBER ITEMS USUALLY CARRIED IN RETAIL YARDS

Lumber is sold in a number of standard general-purpose items and also in certain special-purpose items. Retail lumber yards carry all the general-purpose items and the more important of the special-purpose items. Some lumber items are obtainable in only the upper grades and some only in the lower. There are not many items made in the complete range of grades. A brief description of common boards, dimension, finish, siding, ceiling and partition, flooring, casing and base, shingles, and lath, which are items commonly carried by all retail yards, is given.

COMMON BOARDS

Common boards, also termed "boards", are a general-purpose item available at all yards in one or more of the kinds of wood most fre-

quently used in building. Common boards are usually
1-inch thickness, dressed two sides to twenty-five thirty-se
thick. Sometimes thinner stock is offered, but it cannot b
as standard lumber. The usual nominal widths are 6, 8,
inches. Common boards are manufactured in all grades fr
1 to No. 5, but only No. 1, No. 2, and No. 3 are generally av ..able
in retail yards.

Common boards are sold square edge, dressed and matched (tongue and groove), or with a shiplap joint (fig 7). The principal uses for common boards are subfloors, sheathing, barn boards, roofing boards, rough siding, and concrete forms.

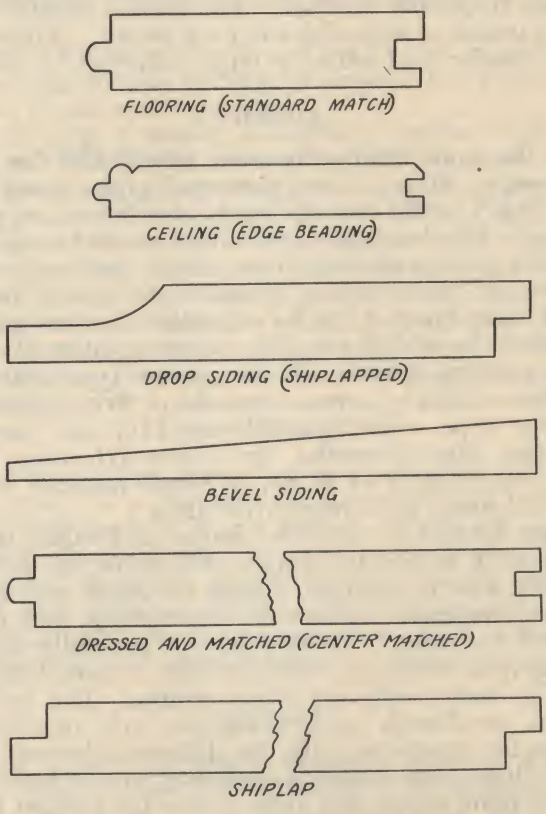

FIGURE 7.—Six typical patterns of lumber.

DIMENSION

Dimension is primarily framing lumber, such as joists, rafters, and studding. It also comprises the planking used for heavy barn floors. Strength, stiffness, and uniformity of size are essential requirements. Dimension is stocked in all lumber yards but frequently in only one of the general-purpose construction woods, such as pine, fir, hemlock, or spruce. It is usually nominal 2 inches in thickness dressed 1 or 2 sides to 1⅝ inches. It is nominal 4, 6, 8, 10, or 12 inches in width, and 4 to 18 feet long in multiples of 2 feet. Dimen-

sion thicker than 2 inches and longer than 18 feet is manufactured but only in comparatively small quantities. The dimension grades are No. 1 Dimension, No. 2 Dimension, and No. 3 Dimension.

FINISH

Finish, except for such special types as knotty pine and pecky cypress, is of select quality and is made in practically all softwoods, although a local lumber yard usually stocks only a few kinds. It is manufactured in all select grades but principally B and Better and C. It is usually nominal 1 inch in thickness, dressed two sides to twenty-five thirty-seconds inch, although nominal 1¼ inches and 1½ inches are frequently stocked. The widths usually stocked are 5 inches to 12 inches in both odd and even inches. Finish goes principally into interior and exterior trim, although it has numerous other uses.

SIDING

Siding, as the name implies, is made specifically for purposes of exterior coverage. It is of two principal types, bevel siding and drop siding (fig. 7); the drop siding is also known as rustic siding or barn siding. Bevel siding is ordinarily stocked only in the select grades of white pine, ponderosa pine, spruce, western red cedar, cypress, or redwood. Drop siding is sometimes stocked both in select and in sound, tight-knotted grades of southern yellow pine, Douglas fir, and hemlock in addition to the woods mentioned under bevel siding. Bevel siding may be of the narrow type with 3½-, 4½-, or 5½-inch face widths by seven-sixteenths or five-eighths inch thick, or of the wide type with 7¼-, 9¼-, or 11¼-inch face width by seven-sixteenths, nine-sixteenths, or eleven-sixteenths inch thick. Drop siding is ordinarily of 5-, 6-, or 8-inch nominal width and is dressed to a thickness of three-fourths inch.

Bevel siding is seldom used for barns and other outbuildings. For one reason it is not ordinarily obtainable in the lower and cheaper grades, and in addition siding on barns and outbuildings is often placed vertically instead of horizontally, and bevel siding cannot be used vertically. Bevel siding is generally lapped three-fourths of an inch with the 3-inch width, 1 inch with the 6-inch width, and 1½ inches with the wider widths. The lap with drop siding is from one-fourth to three-eighths inch, depending on the pattern. The lap combined with the difference between the actual and nominal dimensions makes it necessary to use from 123 to 145 surface feet of bevel siding and from 114 to 128 surface feet of drop siding for every 100 square feet to be covered. The amount required depends on the width of the siding used, the wider widths requiring less excess than the narrower.

CEILING AND PARTITION

Ceiling and partition (fig. 7) are not made or stocked as commonly as in former years, although they are still popular items, usually in the select grades. Although manufactured for a specific use, ceiling and partition are often used for a variety of purposes requiring a finished appearance and where a simple pattern is preferred to plain unbroken surfaces.

FLOORING

Flooring (fig. 7) is made chiefly in the harder softwood species, such as Douglas fir, western larch, and southern yellow pine, and in hardwoods, such as maple and oak. At least 1 of the softwoods and usually 2 hardwoods are stocked in most yards. Flooring is usually of 1 inch nominal thickness, dressed to twenty-five thirty-seconds inch, and is of 3- and 4-inch nominal width. Thicker flooring is available for heavy-duty floors both in hardwoods and softwoods. Thinner flooring is available in hardwoods, especially for recovering old floors. Vertical grain and flat grain, also called quarter-sawed and plain-sawed, respectively, are manufactured in both softwoods and hardwoods, and many dealers carry both types in stock.

Vertical-grain flooring shrinks and swells less in width than does flat-grain flooring, is more uniform in texture, wears more uniformly, and the joints do not open as much.

Softwood flooring is usually available in grades of B and Better, C, or D. The chief grades in maple are First grade and Second grade. The grades in quarter-sawn oak are Clear, Sap Clear, and Select. The grades in plain-sawn oak are Clear, Select, and No. 1. The quarter-sawed hardwood flooring has the same advantages and is cut in the same way as the vertical-grain softwood flooring. In addition the "silver" or "flaked" grain of quarter-sawed oak is frequently preferred to the figure of plain-sawed oak. Beech, birch, maple, and oak are commonly used for flooring in dwellings; and for fancy parquetry flooring, walnut, mahogany, and other woods are also used.

CASING AND BASE

Casing and base, which is stocked in most retail yards in at least one kind of wood, is a standard item in the more important softwoods. The chief grade is B and Better. It is made and graded to meet the requirements of interior trim for dwellings. It is usually of 1-inch nominal thickness, dressed to three-fourths inch, and is of 5-, 6-, and 7-inch nominal widths. Hardwoods, such as oak and birch, for casing and base may be carried in stock in the retail yard or may be obtained and manufactured on special order at the local planing mill.

SHINGLES

One species, western red cedar, furnishes most of the shingles in retail yards, although northern white cedar is sometimes stocked in yards close to its source of supply, and redwood, southern cypress, and other woods are also sometimes stocked. The commercial standards promulgated by the Department of Commerce for cedar, cypress, and redwood shingles provide for only No. 1 grade. Lower grades of all these woods are, however, available on the market. The No. 1 grade is the most economical grade for permanent construction, since this grade provides for all heartwood and edge grain. Shingles that are all heartwood give greater resistance to decay than do shingles that contain sapwood. Edge-grain shingles are less likely to warp than flat-grain shingles; thick-butted shingles, less than thin shingles; and narrow shingles, less than wide shingles. The

standard thickness of shingles are described as 4/2, 5/2¼, and 5/2, meaning, respectively, four shingles to 2 inches of butt thickness, five shingles to 2¼ inches of butt thickness, and five shingles to 2 inches of butt thickness. Lengths may be 16, 18, or 24 inches. Random widths and specified (dimension shingles) widths are available in western red cedar, redwood, and southern cypress; random width in northern white cedar. Random-width shingles are usually packed by the square; dimension, by the thousand shingles.

LATH

Lath are made in nearly all the important softwoods. The chief grades are No. 1 and No. 2. No. 2 lath is commonly used in cottages and low-cost homes. For the most satisfactory service, lath should be moist when the plaster is applied. This can be accomplished by wetting them at that time.

IMPORTANT POINTS IN CONSTRUCTION AND MAINTENANCE

Wood has stood the test of time as a building material. On every hand one finds proof of the permanence that is obtained when wood construction is properly used (fig. 8). Being a material that the inexperienced as well as the experienced man can work and being low-priced, wood has been used too frequently in shoddy construction.

Defects which show up in buildings are frequently ascribed to the material used when in reality they should be ascribed to the design, installation, or maintenance of the building. When defects show up it is natural that the first reaction should be to turn to another wood or some other material as a means of avoiding the defect in the future. Before doing so, however, it is well to be sure that the wood has not been misused or that a simple change in design, fabrication, or methods will not correct the trouble or that even more serious trouble will not be encountered by turning more or less blindly to another wood or another material the drawbacks of which are unknown or have not been carefully considered.

It is important to realize that in wood construction more unsatisfactory service results from the failure to use dry wood and to keep it dry than from any other cause. It is moisture and the changes in moisture content that are largely responsible for decay (fig. 9), plaster cracks, air leakage, pulling of fastenings, vibration of floors, peeling of paint, and the warping and sticking of doors and windows. The man who pays the bill should insist on dry lumber. He can and will get it when he knows its importance. He should assure himself that the dealer from whom he buys has purchased dry lumber and kept it properly piled and protected from the wheather while in his yards. Having obtained dry lumber, he should keep it dry.

HOW TO TELL WHEN LUMBER IS DRY

Regardless of how experienced he is, no man can tell simply by a visual inspection, by lifting it, or by the feel of the wood, whether it is adequately dried. How then can he tell when lumber is adequately seasoned? A rough check can be made rather simply. Select a half

FIGURE 8.—Wood has served in fine homes of the past and promises equal service in the homes of the future: *A*, Over a hundred years ago this home of Ralph Waldo Emerson was built of wood. Well planned and built, it has served down through the years and is still an attractive, serviceable structure. *B*, The wood house at the Century of Progress shows the adaptability of wood to modern architectural treatment and continued service as a home building material.

dozen flat or plain-sawed boards from the lumber pile and cut a sample from each. The sample should measure 1 inch along the grain and be cut so as to include the entire width of the board. It should be cut at least a foot from the end of the board. Trim the sample so that it will measure exactly 6 inches in width and place it in a warm, dry place—under the cookstove, in the warming oven, or on a radiator—and leave it 48 hours or longer, then measure the 6-inch dimension to determine how much it has shrunk. If the wood is classed C in freedom from shrinkage (table 1, column 4) it should not shrink more than one-eighth of an inch if it is to be used for interior trim or finish, nor over twice that amount (one-fourth of an inch) if it is to be used for framing, coverage, or where it is exposed to the weather. Woods classed as B in freedom from shrinkage (table 1, column 4) should not shrink over three thirty-seconds of an inch, and class A woods not over one-sixteenth of an inch if they are to be used for interior trim, finish, or floors, nor over twice that amount (one-

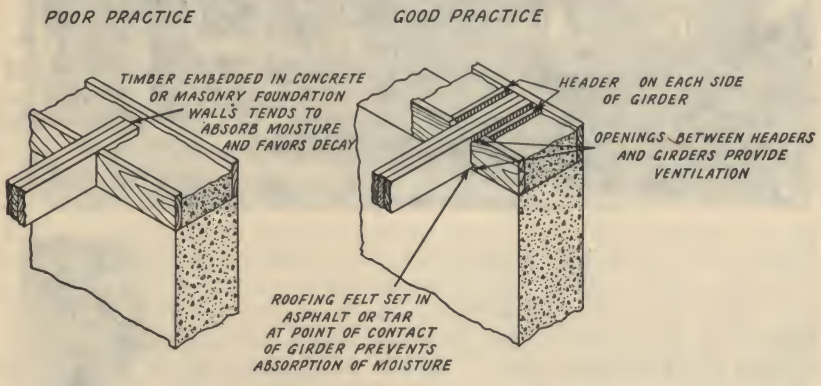

FIGURE 9.—Good and poor practice with girders embedded in concrete or masonry.

eighth of an inch) if they are to be used exposed to the weather. For lumber under 6 inches wide use 3-inch samples. The shrinkage limits should be half those for 6-inch samples. Edge-grain or quarter-sawed lumber shrinks only about one-half as much as plain- or flat-sawed lumber and if it is not possible to obtain a flat-grain sample, an edge-grain sample may be used, in which event the shrinkage should not be over half that shown for flat grain. It is best, however, not to use edge-grain samples or samples shorter than 6 inches; not only are they more difficult to measure, but they do not give so reliable an indication of the adequacy of seasoning.

If it is desirable to measure the adequacy of seasoning more accurately than is possible by the method just described, it can be done by determining the moisture content of the wood and comparing the results with data available on moisture-content requirements for different uses and different climatic conditions. This involves cutting the 1-inch sections from the boards, weighing them accurately, drying them to a constant weight in an oven at 212° F., reweighing, and then computing the moisture content in percentage by dividing the loss in weight by the oven-dry weight. This method is the standard by which

degree of dryness is expressed for technical and commercial purposes. A more complete description of standard methods of determining the moisture content of wood is contained in United States Department of Agriculture Circular 239, Moisture Content of Wood in Dwellings.

HOW DRY SHOULD THE WOOD BE WHEN INSTALLED?

The installation of wood at the proper dryness means practically no serious shrinkage later. Wood at the time of installation should therefore be seasoned to about the average moisture content that it will have in service. The moisture content of interior trim at the time of installation should be in most parts of the United States between 5 and 10 percent; in the damp southern coastal regions, where the humidity is high, the moisture content should be between 8 and 13 percent; and for the dry southwestern region, where the humidity is low, the moisture content should be between 4 and 9 percent. The moisture content of sheathing, framing, siding, and exterior trim at the time of installation should be between 9 and 14 percent moisture in most parts of the United States, and between 7 and 12 percent in the dry southwestern regions. Department of Agriculture Circular 239, Moisture Content of Wood in Dwellings, contains a full discussion of this subject.

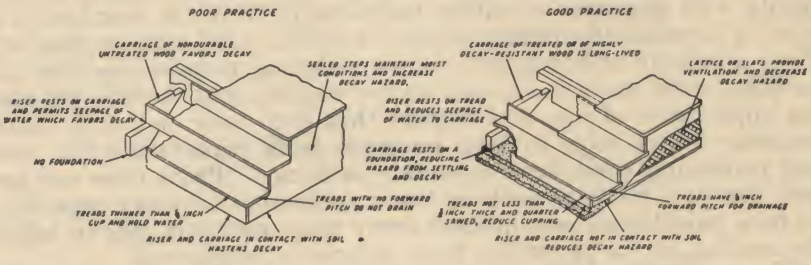

FIGURE 10.—Good and poor practice with porch steps.

HOW TO KEEP LUMBER DRY IN SERVICE

Dry wood takes up moisture not only from actual contact with water but from other sources commonly overlooked. It may take up moisture in the form of vapor from damp air or from damp plaster, concrete, soil, or brickwork. It will absorb moisture that has condensed on it, as well as rain or snow that has percolated into joints, crevices, or other pockets. The protection of woodwork from moisture, therefore, requires not only that it be kept from contact with soil and water but also that moisture pockets, where water can enter but not drain out, be avoided; that free circulation of air be provided wherever the air is likely to become damp, as under porches, steps (fig. 10), and portable buildings; and that surfaces exposed to the weather, damp air, or condensation be coated with paint, varnish, or other protective coatings to reduce the absorption of moisture. Protective coatings, however, reduce but do not prevent moisture absorption, and therefore cannot be relied on to compensate for poor drainage and poor ventilation.

HOW TO PREVENT DEFECTS DUE TO SHRINKAGE

Satisfactory service will be realized when the shrinkage factor is recognized and properly controlled.

Unsatisfactory service due to shrinkage can be largely eliminated by (1) using only thoroughly seasoned wood (means of determining whether wood is dry enough for use are discussed on p. 36); (2) protecting by paint, varnish, or other protective coatings all exposed surfaces of dry wood in place so that rapid moisture changes will not take place; (3) selecting woods with low inherent shrinkage; or (4) using quarter-sawed or edge-grain material in preference to flat grain.

The application of the first two rules will insure wood that will meet the ordinary requirements of construction. More exacting requirements, such as those of doors, window sash, and frames, require in addition either the selection of woods from the low-shrinkage group or quarter-sawed material. Special conditions often prevent the application of all four rules. One or more of the rules, however, is always applicable, and their application will generally enable wood to meet the shrinkage requirements satisfactorily.

HOW AND WHEN TO PAINT

The purpose of painting must be looked upon as having to do primarily with appearance—either temporarily from the standpoint of color or permanently in the manner in which wood ages or weathers. From a strictly utility point of view painting reduces cracking and warping when wood is exposed to the weather and thereby prevents the appearance of age and neglect that even later painting cannot remove. Paint helps to keep moisture from penetrating the wood and producing conditions favorable to decay. Paint does not prevent decay; it contains nothing that is poisonous to decay organisms. In fact, paint sometimes hastens decay when moisture gets in behind the coating and is prevented from promptly drying out.

The painting characteristics of different kinds of wood are discussed on page 19.

The character of the paint itself is of importance to the life of the job. In selecting paint, particularly for the larger jobs, the advantages of both ready-mixed and home-mixed paints should be considered. Ready-mixed paints of the better brands show on the label the formula of their composition. Information on the different components of paint is presented in When and How to Paint Farm Buildings, published in the report of the President's Conference on Home Building and Ownership, copies of which are available for distribution at the Forest Products Laboratory. Other practical information on painting and wood finishing is contained in Farmers' Bulletin 1452, Painting on the Farm.

The priming coat should be applied to the exterior of a new building as soon as possible. The second coat should not be delayed more than 2 weeks. The practice of delaying the third coat several months to a year is poor. It should be applied as soon as the second coat is dry, ordinarily within 2 weeks. Interior woodwork should not be painted until the plaster has dried.

Paint surfaces should be examined carefully from time to time to determine when repainting is necessary to protect wood properly from moisture. Exterior surfaces should be repainted as soon as a close inspection reveals that the coating is beginning to break up and fall off in flakes. Postponing the repainting until the paint coating is badly disintegrated and the wood exposed leads to warping and checking of the wood and makes repainting more difficult and the results less satisfactory. Paint rarely fails on interior protected surfaces and repainting is generally done to improve the appearance rather than to protect the wood.

Occasionally wood painted when very wet or green may blister, but paint is seldom applied to wood wet enough to cause blistering. The prevention of blistering, therefore, lies not in the selection of the wood or paint but in obtaining tight construction and avoiding or correcting any condition that produces an excessive amount of moisture in the building (figs. 3, 4, and 11), especially in the basement or cellar.

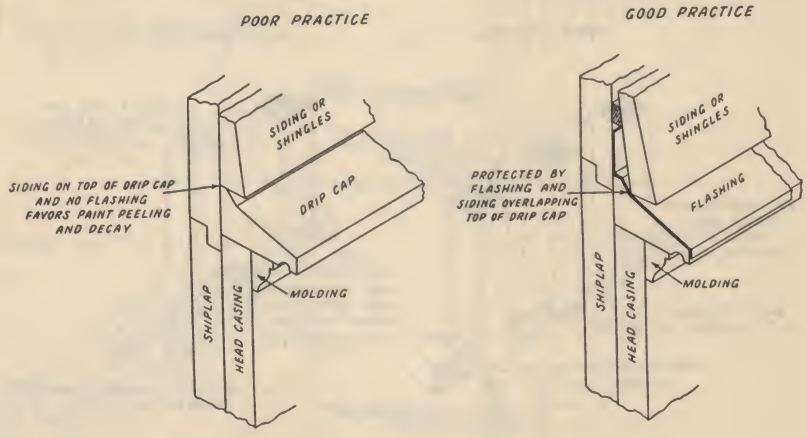

FIGURE 11.—Good and poor practice with drip caps.

HOW TO PREVENT DECAY

The simplest method of preventing wood from decaying is to keep it dry. Keeping wood dry entails protecting it from the quite generally recognized decay hazards created by the contact of wood with the ground, by leaks, and by actual contact of wood and water. It also entails protecting wood from such generally unrecognized decay hazards as are caused by relatively small amounts of water that get into the wood and cannot get out. Water is usually held in the wood by some type of covering or by lack of ventilation or drainage. Many of the unrecognized decay hazards are at joints that are exposed to the weather and at surfaces where the wood is in contact with other materials. Very frequently it is cheaper and easier to change the construction details so as to keep the moisture out than to follow poor design and rely on especially decay-resistant or treated wood.

It is obviously impossible to point out all the construction details that are responsible for unrecognized hazards but a few of the more common ones can well be pointed out as examples of what to guard against. The reader is referred to the various sketches in the figures of this bulletin which show good and poor practice in several important building details. Four main principles of design to be observed in the use of wood are involved in the building details shown: (1) Provision for free drainage to prevent water from accumulating at the foot of posts, columns, behind cross rails and battens, and at the bottoms of exterior doors and in joints of exterior stepping; (2) the use of good ventilation to prevent the accumulation of damp air under porches and steps and around the roofing and rafters of barns; (3) providing protection to wood from condensation, such as occurs on cold-water pipes, on window glass, especially in dairy barns, bathrooms, kitchens, and all artificially humidified rooms; (4) the use of protective coatings, such as roofing felt, tarred and mopped down, to prevent absorption from damp concrete, masonry, or earth. (Figs. 5, 10, 12, 13, 14, 15, and 16.)

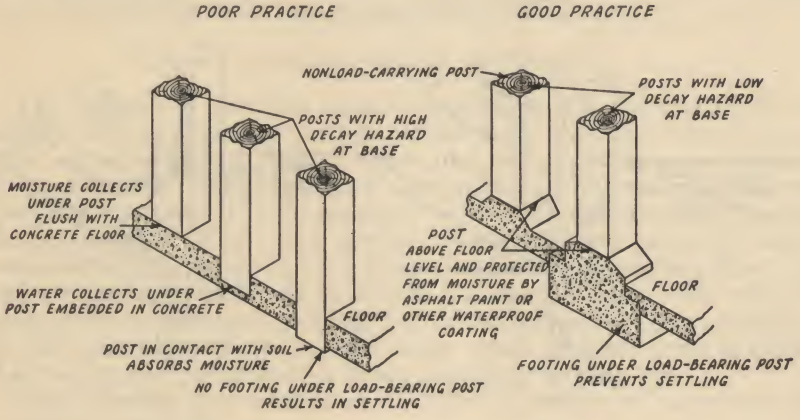

FIGURE 12.—Good and poor practice with posts.

Many of the commonly recognized decay hazards cannot be eliminated or modified by design or by the use of protective coatings. The conditions of use are such that wood of necessity is in contact with the ground or subject to frequent contact with water. There is no practical method by means of which wood piers to buildings, fence posts, sills in contact with the ground, or sleepers embedded in concrete can be kept dry. The protection against the decay hazard in such uses lies in poisoning the wood so that the decay organisms cannot attack it or in using naturally decay-resistant woods. Figures 2 and 16 illustrate the types of uses that require treated or decay-resistant woods.

Any wood adequately treated with preservatives will generally prove more decay resistant than a naturally resistant species. This is true only when the wood has received something more thorough than a brush treatment. The best and most effective treatment is made under pressure and is essentially a commercial process. Where no treating plant is available and the local lumber dealer does not

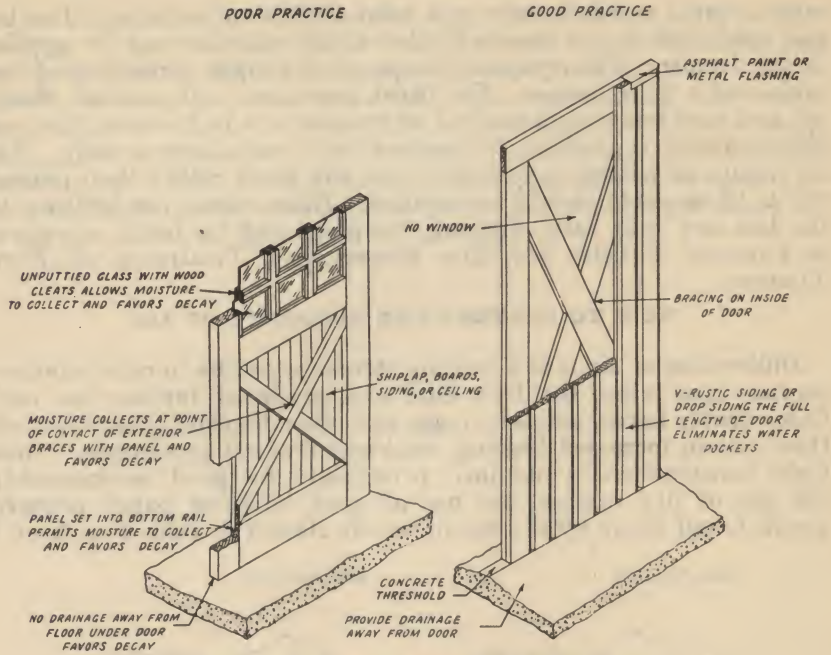

FIGURE 13.—Good and poor practice with garage doors.

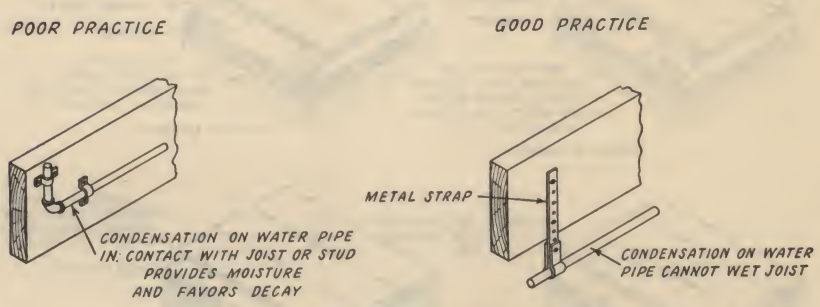

FIGURE 14.—Good and poor practice with water pipes.

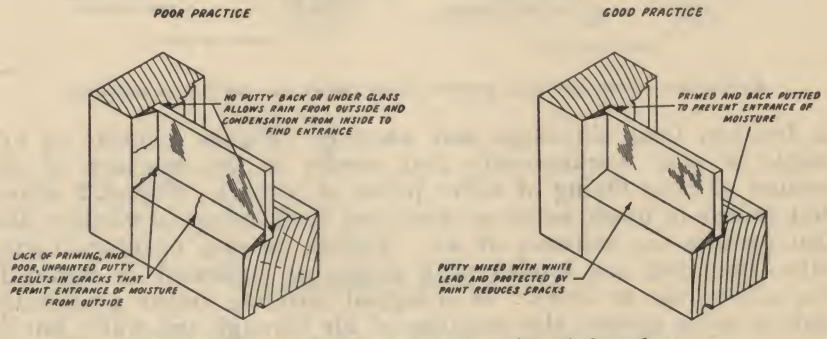

FIGURE 15.—Good and poor practice with window glass.

carry treated wood, farmers can treat their own material. The hot and cold bath is the most effective treatment that can be applied by the farmer. The equipment required is simple, consisting of two tanks and a thermometer. The brush treatment is the easiest, cheapest, and most convenient method of treating. It is, however, the least effective, and is suitable for creosote and carbolineums only. The oil should be heated and flooded over the wood rather than painted on it. Two coats should be applied. Instructions for treating by the hot and cold bath, dipping, steeping, and by brush are given in Farmers' Bulletin 744, The Preservative Treatment of Farm Timbers.

HOW TO PREVENT THE ENTRANCE OF AIR

Infiltration of air into a housing structure results in unsatisfactory service even when the best kind and grade of lumber are used. Cold, drafty barns, chicken coops, and other housing structures take their toll in increased heating costs and lowered production. Good tight construction is obtained principally by good workmanship, the use of dry lumber, the use of good building paper properly applied, and lastly by the use of woods classed in table 1 as A or B

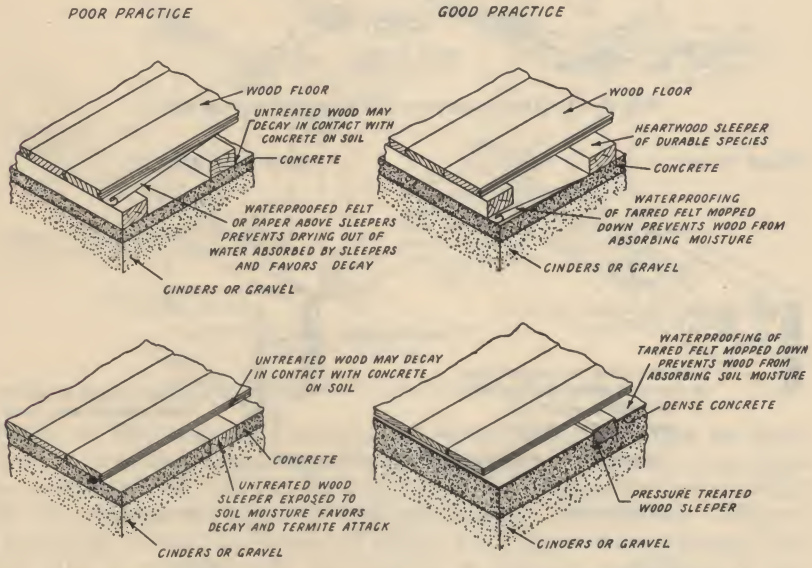

FIGURE 16.—Good and poor practice with timber on concrete or masonry.

in freedom from shrinkage and warping. Figure 4 shows an example of poor workmanship that results in the entrance of air because of poor fitting of miter joints at corners. Figure 3 shows that failure to break joints on studs and to fit siding to window sills also permits the entrance of air. Failure to stop openings under sills after they are leveled with shims, as indicated in figure 1, also allows air to enter. Well-lapped building paper practically seals a house against the entrance of air through the walls, but it cannot protect the house against poor fitting at the openings.

Neither should it be relied on to seal the structure against air entering the large cracks that develop between boards in sheathing and subfloor when wet lumber is used in construction.

Good building paper is most efficient in excluding air when clamped between two coverings, such as sheathing and drop or bevel siding. Building paper applied vertically between the studding and sheathing with laps on studding will satisfactorily exclude air in barns and other shelter buildings if special precautions are taken at the corners and openings.

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